

UNDERSTANDING MIXTURES

CHEMISTRY WORKSHOP-2



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BEFORE YOU BEGIN . . .

Can you mix a pitcher of lemonade or make a milkshake? Then you can make different kinds of mixtures. Just about everything in our lives—what we drink, even the air we breathe—is a mixture. Some things are “100% pure,” but most things are mixtures. That is what this book is about.

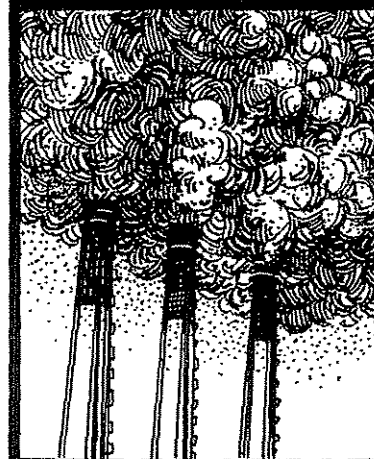
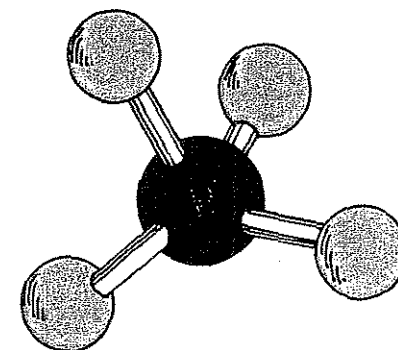
You will learn the answers to some practical questions in this book. You’ll find out why antifreeze works in cars and why lemons are sour. You’ll learn why soda pop loses its “fizz” and why steam makes a tea-kettle whistle.

This book is set up in a special way. Each Aim begins with the things you’ll need to know. This is followed by a series of exercises. Take your time on these. And look back to the beginning of the Aim when you’re not sure of an answer. There will be experiments along the way—and a few surprises, too.

So get ready. It’s full steam ahead!

WHAT IS A MIXTURE?

1



element: matter made of one kind of atom

compound: matter made of different kinds of atoms linked together

molecule: the tiniest part of a compound

mixture: two or more elements or compounds close together

states of matter: { solid
liquid
gas

AIM | What is a mixture?

1

Look around you. What do you see? A room filled with people, desks, windows? Everything you see around you is matter. Matter is anything that has weight and takes up space.

As you probably already know, matter is made up of tiny particles called atoms. Atoms are so tiny that they cannot be seen—not even with the most powerful microscope.

There are only 106 different kinds of atoms. Some matter has only one kind of atom. Matter that has only one kind of atom is called an *element*. Some examples of elements are gold, oxygen, iron, and hydrogen.

Most matter, however, is made up of two or more different kinds of atoms linked together. This kind of matter is called a *compound*. In a compound, the atoms are linked together to form *molecules*.

Water is a common compound. Some other compounds are salt, alcohol, and chalk.

Some elements and compounds are found “alone.” They are not mixed with anything else. The salt in a salt shaker, for example, is a compound. It is salt “alone.” No other substance is mixed in with it. If you add pepper, or anything else to the salt, it is no longer salt “alone.” It is part of a mixture.

A mixture, then, is made up of two or more different things close together. The parts may be different in any way. The parts can be elements or compounds.

Many things you know are mixtures. Tossed salads, salad dressing, coffee, tea—even soft drinks—are mixtures.

As you know, matter can be a solid, liquid, or gas. These are called the three states of matter. Mixtures may be of solids only, liquids only, or gases only. Or, mixtures may be made of different combinations of solids, liquids, and gases.

The air you breathe and the water you drink are mixtures. Air is a mixture of several gases. Drinking water has air and minerals mixed in with it.

ELEMENT, COMPOUND, OR MIXTURE?

Figures A through E show some common substances.

In the blank below each picture, write whether the arrow points to an element, compound, or mixture.

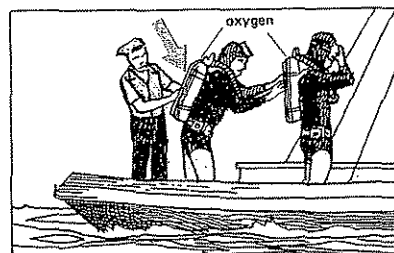


Figure A

1. _____



Figure B

2. _____



Figure C

3. _____

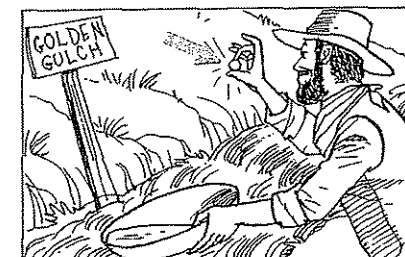


Figure D

4. _____

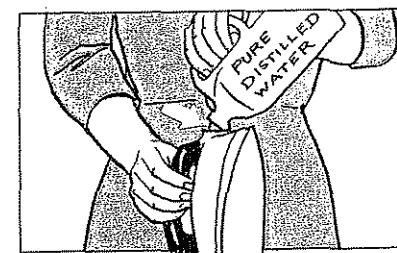


Figure E

5. _____

WHAT KIND OF MIXTURE?

Six of the possible kinds of mixtures are:

- | | |
|-------------------------|------------------------------------|
| a. a mixture of gases | d. a mixture of gases in a liquid |
| b. a mixture of liquids | e. a mixture of solids in a liquid |
| c. a mixture of solids | f. a mixture of solids and gases |

In Figures F through K, each arrow points to a mixture described in the list above. Write the letter that shows what kind of mixture it is below each picture.



Figure F

1. _____

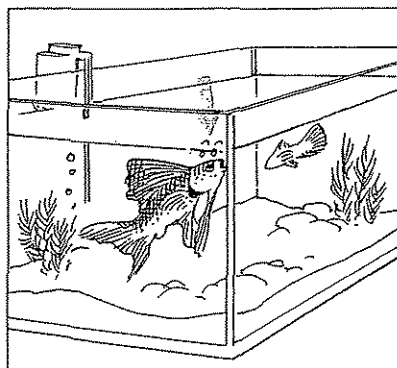


Figure G

2. _____

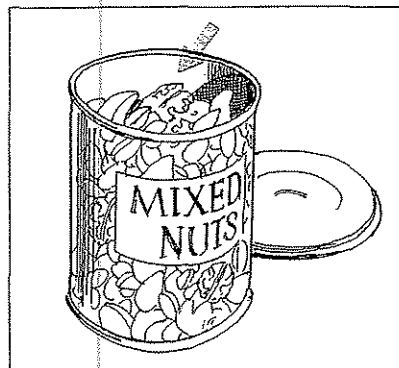


Figure H

3. _____

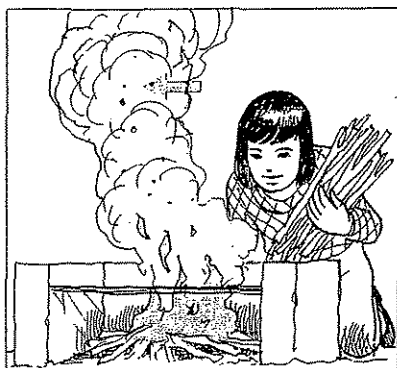


Figure I

4. _____



Figure J

5. _____

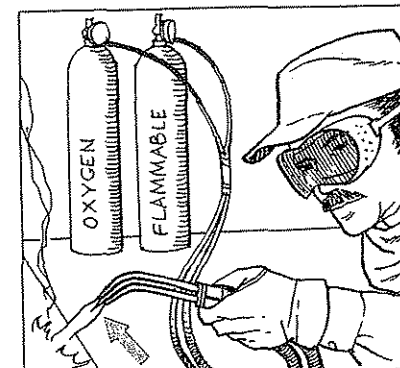


Figure K

6. _____

COMPLETING SENTENCES

Complete the sentences with the choices below. One of these may be used twice.

atoms
liquid
molecules
gases

states of matter
solid
minerals
compound

element
mixture
gas
air

- The three states of matter are _____, _____, and _____. (Use singular form.)
- Every bit of matter is made up of tiny _____.
- Matter that has only one kind of atom is called an _____.
- Matter that has two or more different kinds of atoms linked together is called a _____.
- Atoms link together to form _____.
- Two or more different things close together is called a _____.
- A mixture may contain any combination of the _____.
- A mixture that is all around us is the _____.
- Air is a mixture of _____.
- Water has several _____ and _____ mixed in it.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | | |
|----------|--------------------|---|
| 1. _____ | element | a) has two or more different kinds of atoms linked together |
| 2. _____ | compound | b) mixed in with water |
| 3. _____ | mixture | c) a mixture of gases |
| 4. _____ | gases and minerals | d) different things close together |
| 5. _____ | air | e) has only one kind of atom |

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ All matter is made up of atoms.
2. _____ A compound has only one kind of atom.
3. _____ An element has only one kind of atom.
4. _____ There are more compounds than elements.
5. _____ Mixtures are made of substances that are alike.
6. _____ Table salt is a mixture.
7. _____ The air is a mixture.
8. _____ Water is a mixture.
9. _____ Oxygen is a compound.
10. _____ We can see atoms.

WHAT IS A LIQUID SOLUTION?

2



liquid solution: a liquid mixture where the parts dissolve and spread out evenly

solute: the part of a liquid solution that dissolves

solvent: the liquid in a liquid solution

soluble: able to dissolve

AIM | What is a liquid solution?

2

You can be a magician! Just add sugar to water and stir. Abracadabra! The sugar disappears!

But is it really gone? No. The sugar and water just mix together. They mix completely. The sugar just seems to disappear.

Sugar and water together form a mixture. There are several kinds of mixtures. Sugar and water form a special kind of mixture. They form a liquid solution.

A liquid solution has two parts: a solute [SOLL yoot] and a solvent [SOLL vent]. The solvent is always a liquid. The solute is what "disappears" in the solvent. The solute may be a solid, a gas, or another liquid.

A liquid solution is formed when the solute dissolves. The solute spreads out evenly throughout the solvent. The substance that dissolves is said to be soluble [SOLL yuh bul].

In the example of sugar and water, the water is the solvent. Water dissolves sugar. The sugar is the solute. Sugar is soluble in water.

There are many kinds of solvents. There are many kinds of solutes. There are many kinds of liquid solutions.

Remember, a mixture is a liquid solution only if the solute dissolves and spreads out evenly.

LIQUID SOLUTIONS AND THE STATES OF MATTER

All the examples in Figures A, B, and C are liquid solutions.

Remember, there are three states of matter—solid, liquid, and gas.

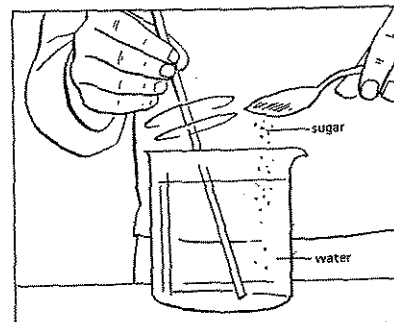


Figure A

1. a) Name the states of matter in this liquid solution (Figure A).

_____ and _____

- b) The solute is the

_____ solid, liquid

- c) The solvent is the

_____ solid, liquid

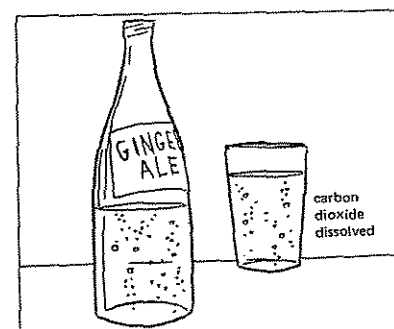


Figure B

2. a) Name the states of matter of this liquid solution (Figure B).

_____ and _____

- b) The solute is the

_____ gas, liquid

- c) The solvent is the

_____ gas, liquid

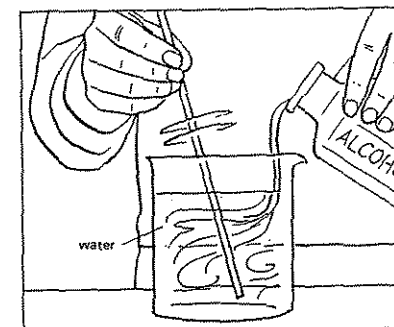


Figure C

3. Name the states of matter of this liquid solution (Figure C).

_____ and _____

NOTE: In solutions where all the parts are liquid, we usually do not name the solute and solvent.

FILL IN THE BLANKS Write the correct term in each blank to answer the question or complete the sentence.

- Which state of matter is part of all these solutions? _____
- A liquid solution has at least one _____
solid, liquid, gas
- The solute in a liquid solution _____
must be a gas, must be a solid, can be any state of matter
- In solutions of liquids and solids or of liquids and gases, the solvent is always the _____
solid, liquid, gas
- In solutions of all liquids, we usually _____ name the solute and solvent
do, do not

WHICH ARE LIQUID SOLUTIONS? Ten mixtures you know are listed below. Some are liquid solutions. Some are not. Think about each mixture.

Fill in the boxes.

Mixture	Do the substances dissolve? (Write YES or NO.)	If the substances dissolved, name the solute (or solutes) name the solvent.	
1. sugar water			
2. muddy water			
3. salty water			
4. pebbles in water			
5. instant coffee drink			
6. orange juice			
7. oil and water			
8. instant tea drink			
9. ocean water			
10. vegetable soup			

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

mixture
two
solid
soluble

liquid solution
liquid
gas
water

sugar water
solvent
solute

- Different things close together make up a _____.
- A _____ is a special kind of mixture.
- An example of a liquid solution is _____.
- A liquid solution has _____ main parts.
- One part of a liquid solution is always a _____.
- The liquid part of a liquid solution is called the _____.
- The other part of a liquid solution can be a _____, or a _____, or a _____.
- The part of a liquid solution that mixes into the solvent is called the _____.
- A solute that dissolves in a solvent is said to be _____.
- Sugar is soluble in _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- _____ mixture
- _____ solute
- _____ solvent
- _____ liquid solution
- _____ soluble

- means "able to dissolve"
- liquid part of a liquid solution
- different things close together
- a special kind of mixture
- part of a solution that is dissolved

REACHING OUT

Be a detective! How can you tell if a mixture is a liquid solution? We will learn more in following Aims. Meanwhile, let's see if you can figure out the clues.



Figure D

- This is a mixture of muddy water.
- Muddy water is not a liquid solution.



Figure E

- This is a mixture of sugar and water.
- Sugar and water is a liquid solution.

Answer YES or NO to these questions.

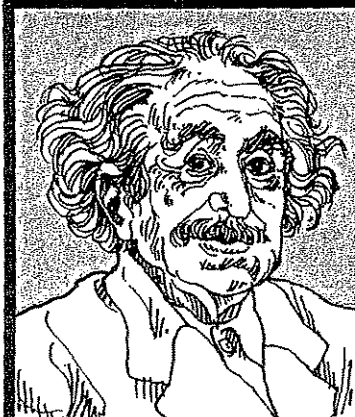
	Muddy Water	Sugar and Water
1. Are the parts evenly mixed?		
2. Can you see the separate parts?		
3. Do particles fall to the bottom?		
4. Can you see clearly through this mixture?		

How can you tell if a mixture is a liquid solution?

In your own words, list the clues.

WHAT CAN WE OBSERVE ABOUT LIQUID MIXTURES?

3



observation: what you see
miscible: mixable
immiscible: not mixable

AIM | What can we observe about 3 liquid mixtures?

Albert Einstein, Marie Curie, Louis Pasteur. . . . These are the names of some great scientists. What made them great? They looked around them and saw things in a new way. They made new and important observations.

Making observations is something that you can do, too. In this Aim you will do some experiments with liquid mixtures. You will observe what happens to them.

Experiments and observations are part of the scientific method. The scientific method is a way of finding the answer to a question in several steps.

Scientists use this method to solve problems in the laboratory. But you can use the scientific method, too. It is usually the most sensible way to solve any problem.

These are the steps to the scientific method:

- (1) Start with a question.
- (2) Get all the information about the question.
- (3) Take a guess at what the best answer is.
- (4) Plan an experiment to show if that is the answer.
- (5) Do the experiment. Make careful observations.
- (6) From your observations, decide if your guess was right or wrong. This is your conclusion. Sometimes you cannot make a conclusion. You have to do the experiment over and over!!

The experiments in this Aim have been planned for you. All you have to do is do them! Remember, don't just look—observe.

WHAT HAPPENS WHEN WE MIX A SOLID AND A LIQUID?

MIXING COPPER SULFATE AND WATER

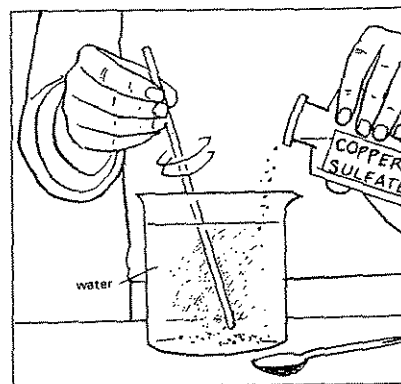


Figure A

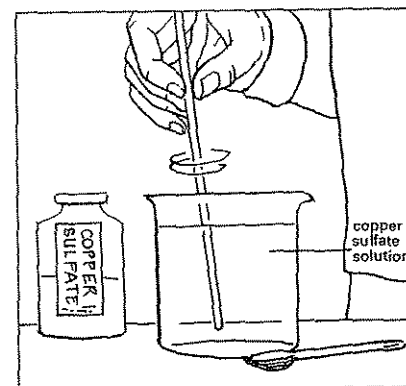


Figure B

What You Need beaker
water
powdered copper sulfate
scoop
stirrer

What To Do Copper sulfate is a blue solid.
Add a small amount of powdered copper sulfate to the water and stir well.

What You Saw and Learned Check your observations in the chart, and fill in the blanks in the sentences.

	YES	NO
1. Does copper sulfate dissolve in water?		
2. Does the mixture have a color?		
3. Is the color the same all over?		

4. The parts of this mixture _____ are, are not completely mixed.

5. This mixture _____ is, is not a liquid solution.

6. The solvent is _____ water, copper sulfate

7. The solute is _____ water, copper sulfate

MIXING SALT AND WATER

What You Need beaker
water
salt crystals (NaCl)
scoop
stirrer



Figure C

What To Do Add a small amount of salt to the water and stir well.

What You Saw and Learned Check your observations in the chart below, and fill in the answers to the questions.

	YES	NO
1. Does the salt dissolve in water?		
2. Does the mixture have a color?		
3. Does the mixture look the same all over?		

4. The parts of this mixture _____ completely mixed.
are, are not

5. All the salt _____ dissolve.
does, does not

6. This mixture _____ a solution.
is, is not

7. Salt is a _____.
solid, gas

8. The salt is the _____.
solvent, solute

9. The water is the _____.
solvent, solute

WHAT CONCLUSIONS CAN WE MAKE ABOUT SOLUTIONS?

1. A liquid solution _____ have a color.
can, cannot
2. In a liquid solution that has color, the color _____ the same all over.
is, is not
3. The color of a liquid solution is the same all over because the parts _____ mixed completely.
are, are not
4. Look at the solutions closely. You _____ see the separate parts of a liquid solution.
can, cannot

WHAT HAPPENS WHEN WE MIX LIQUIDS?

When two or more liquids mix completely, we say they are miscible [MISS uh bul]. Let us test three liquids and see if they are miscible in water.

What You Need 2 beakers half full of water
1 beaker three-quarters full of water
oil
vinegar
alcohol
3 stirring rods

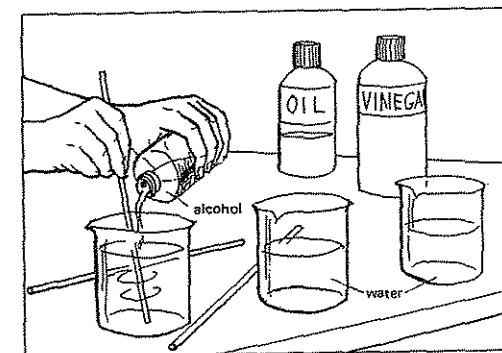


Figure D

What To Do Add a small amount of each liquid to a clean beaker of water. Stir.

What You Saw and Learned Write your observations in the chart below. Answer YES or NO.

	Alcohol and Water	Oil and Water	Vinegar and Water
1. Do the liquids mix completely?			
2. Are the liquids miscible?			
3. Do they form a solution?			

WHAT CONCLUSIONS CAN WE MAKE ABOUT LIQUID MIXTURES?

1. Only certain liquids are _____ in water.
2. Only certain liquids form a _____ with water.

WHAT HAPPENS WHEN WE MIX A GAS AND A LIQUID?

Let us see if a gas dissolves in a liquid. The gas we can use most easily is carbon dioxide. Carbon dioxide is the gas that we breathe out.

How can we tell when we have carbon dioxide? Easy! When it is in a solution of clear limewater, it turns milky.

See for yourself:

What You Need

beakers (3) (label A, B, and C)
water
straws
limewater solution

What To Do

1. Pour limewater into beaker A.
2. Using a straw, blow into the limewater.

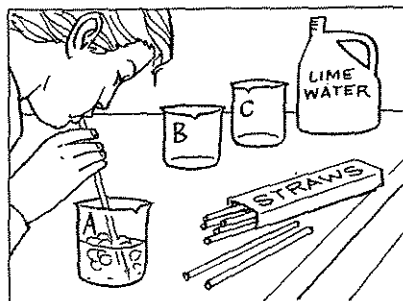


Figure E

3. The clear limewater _____ with carbon dioxide.
stays clear, turns cloudy

The limewater test is often used to see if carbon dioxide is present. Now let us use this information to see if carbon dioxide dissolves in water.

4. Pour some clear water into beaker B.
5. Using a straw, blow into the clear water.
6. The bubbles are made of _____ gas.

carbon dioxide, oxygen

7. The liquid appears _____.

clear, cloudy

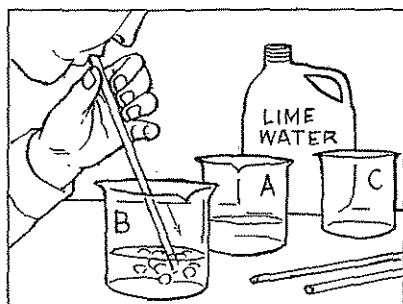


Figure F

8. Now pour a small amount of limewater into Beaker C.

9. Mix half the liquid from Beaker B into C.

10. The mixture _____.

stays clear, turns cloudy

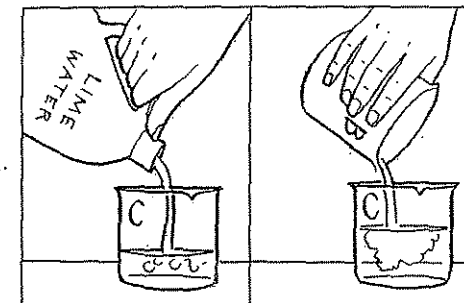


Figure G

What You Learned

11. The carbon dioxide _____ dissolve in the water.
did, did not
12. Carbon dioxide _____ soluble in water.
is, is not
13. Carbon dioxide and water _____ form a liquid solution.
do, do not
14. The solute is _____.
carbon dioxide, water
15. The solvent is _____.
carbon dioxide, water
16. Take a guess! All gases _____ dissolve in water.
do, do not

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------|-------------------------------------|
| 1. _____ miscible | a) means "able to dissolve" |
| 2. _____ soluble | b) mixable |
| 3. _____ solute | c) special kind of mixture |
| 4. _____ solvent | d) liquid part of a liquid solution |
| 5. _____ liquid solution | e) can be a solid, liquid, or gas |

COMPLETING SENTENCES Complete the sentences with the choices below. One term may be used twice.

colorless
solute
oil and water
states of matter

immiscible
liquid
miscible
mixture

salt water
solvent
water and alcohol

1. A liquid solution is a special kind of _____.
2. The main parts of a liquid solution are the _____ and _____.
3. The solute of a liquid solution may be any of the three _____.
4. The solvent of a liquid solution is always a _____.
5. Some liquid solutions have a color. Others are _____.
6. Two examples of colorless liquid solutions are _____ and _____.
7. Liquids that form a liquid solution are said to be _____.
8. An example of miscible liquids are _____.
9. Take a guess! The word that means not miscible is _____.
10. An example of immiscible liquids is _____.

THE SCIENTIFIC METHOD Use these words to describe the scientific method.

conclusion
observations

experiment
information

question
guess

1. Start with a _____.
2. Get all the _____ about the question.
3. Take a _____ at the answer.
4. Plan an _____.
5. Make careful _____ of what you see.
6. Finally, from your observations make your _____.

DOES WATER DISSOLVE EVERYTHING?

4



tincture: alcohol solution
universal: found everywhere

AIM | Does water dissolve 4 everything?

You get a stain on your clothes. What do you reach for first? Probably water. You know from experience that water is a good solvent. It dissolves many things.

Water is the most used solvent. It is so popular, it is called the "universal" [yoo nuh VUR suhl] solvent.

Water may be a good solvent, but it does not dissolve everything. Special solvents are needed to dissolve certain substances.

You have probably put iodine on a cut. Well, here is a surprise. Iodine is a solid, not a liquid. It has been dissolved in alcohol. The solution is called "tincture [TINK cher] of iodine." The iodine would not dissolve in water. A solution that has alcohol for the solvent is called a tincture.

If you put salt in water, the salt dissolves. But if you put salt in alcohol, it does not dissolve.

So, alcohol dissolves iodine, but not salt. Water dissolves salt, but not iodine. Solvents are selective. This means they dissolve certain things but not others.

USES FOR SOLVENTS

Solvents have many uses in our daily lives.



Figure A



Figure B



Figure C

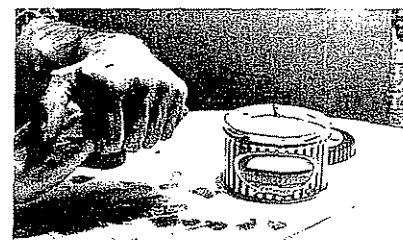


Figure D

They are used in industry.



Figure E



Figure F

WARNING: Never inhale solvents. They can be deadly.

Solvents are also used in medicine.

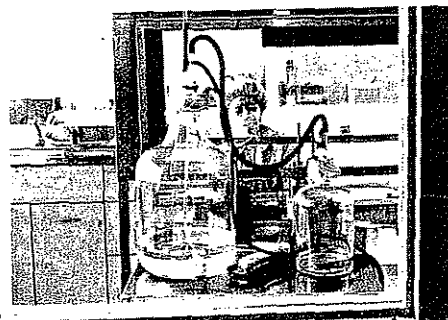


Figure G

1. Name two solvents that you see on these pages. _____
2. How many have you used? _____
3. Name a solvent that you do not see on these pages. _____

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

tincture
water
iodine
selective

industry
sugar
universal

solid
alcohol
salt

1. The most popular solvent is _____.
2. Water is such a popular solvent that it is called the _____ solvent.
3. Two solids that water can dissolve are _____ and _____.
4. A solid that water cannot dissolve is _____.
5. Iodine is a _____.
6. Iodine does not dissolve in _____.
7. Iodine does dissolve in _____.
8. A solution that uses alcohol as a solvent is called a _____.
9. Solvents dissolve only certain things. This means that solvents are _____.
10. Many special solvents are used in _____.

LET'S DO SOME TESTING

What dissolves what?

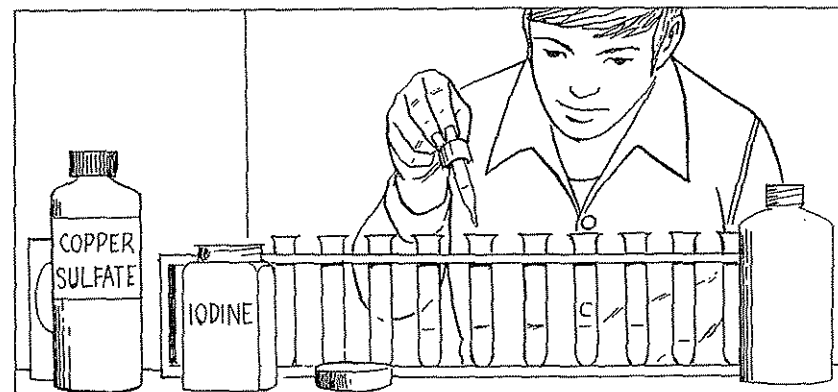


Figure H

What You Need 10 test tubes + corks turpentine
powdered copper sulfate butter
alcohol tar
water gasoline
iodine salt
oil

Mix small amounts of the following substances in clean test tubes. Cork them and shake gently. Write your observations in the chart below.

	Mixture	Do they dissolve?	Do they form a liquid solution?
1.	powdered copper sulfate and water		
2.	powdered copper sulfate and alcohol		
3.	water and iodine		
4.	alcohol and iodine		
5.	water and oil		
6.	turpentine and oil		
7.	butter and water		
8.	tar and water		
9.	tar and gasoline		
10.	salt and alcohol		

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Water is the most popular solvent.
2. _____ Water dissolves everything.
3. _____ Alcohol is called the universal solvent.
4. _____ Water dissolves salt.
5. _____ Alcohol dissolves salt.
6. _____ Iodine is a liquid.
7. _____ All solutions are tinctures.
8. _____ Only solutions with alcohol are tinctures.
9. _____ Solvents are used in homes.
10. _____ Solvents are selective.

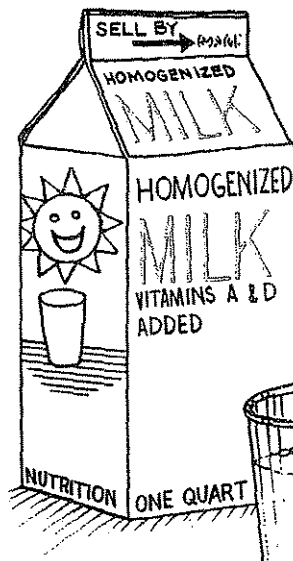
REACHING OUT

1. You should never try to remove a stain with a solvent you are not sure of. Why?

2. Turpentine or paint thinner is often used to clean paint brushes. When would turpentine or paint thinner not be used to clean paint brushes? Explain.

WHAT ARE THE PROPERTIES OF LIQUID SOLUTIONS?

5



homogeneous: evenly mixed, the same all through

transparent: clear

property: anything about the way a thing looks and acts that helps us identify the thing

AIM | What are the properties of 5 | liquid solutions?

What happens when you add salt to a jar of water and stir? The salt disappears. You have made a liquid solution. Does the same thing happen when you add sand to water? No. The sand settles to the bottom of the jar.

How can we tell if a mixture is a solution or not? We can tell by its properties. Properties tell us how a kind of matter looks and acts.

These are the properties of liquid solutions:

- (1) The parts are the size of molecules.
- (2) Liquid solutions are homogeneous [ho MO] uh nus].
- (3) Liquid solutions are transparent [trans PARE ent].
- (4) Liquid solutions do not settle out.

MOLECULE SIZE You know that matter is made of tiny atoms. Most matter is made of groups of atoms called molecules. In a liquid solution, the particles of solute break up until they are the size of molecules.

HOMOGENEOUS Homogeneous means evenly mixed, the same all through. Because the particles are the size of molecules they weigh very little. They move around and spread out evenly.

TRANSPARENT You can see clearly through something that is transparent. Glass is transparent. So are liquid solutions. The molecules that make them up are tiny. They don't block out light. Light passes right through.

THE PARTS NEVER SETTLE OUT Something that settles out drops to the bottom of its container. The parts of a liquid solution never separate. They never settle out no matter how long they sit. That is because the molecules are light. They keep bouncing around. This also keeps the solution homogeneous.

CHOOSE
ONE

Look at each figure. Then choose the correct word or term for each statement. Write your choice in the space.

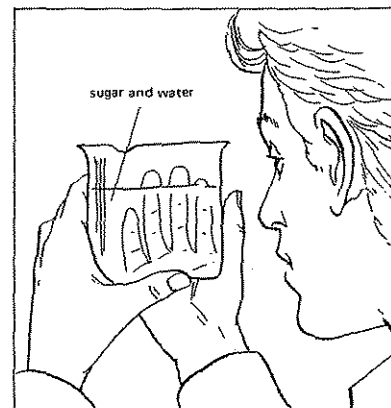


Figure A

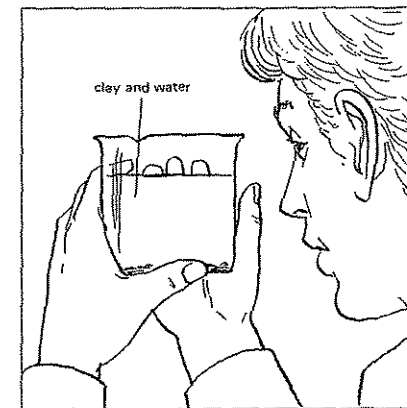


Figure B

1. The boy _____ see clearly through the sugar water.
can, cannot
2. Sugar water _____ transparent.
is, is not
3. The parts of sugar water are _____
the size of molecules, larger than molecules
4. Particles the size of molecules _____ stop light.
do, do not
5. The sugar _____ settling to the bottom.
is, is not
6. The mixture in Figure A _____ homogeneous.
is, is not

Conclusions

7. The mixture in Figure A _____ homogeneous.
is, is not
8. Sugar water _____ a liquid solution.
is, is not
9. The boy _____ see clearly through the clay water.
can, cannot
10. Clay water _____ transparent.
is, is not

11. The clay pieces are _____ the size of molecules, larger than molecules.
12. Particles larger than molecules _____ stop light.
do, do not
13. The clay pieces _____ settling out.
are, are not
14. The clay pieces _____ evenly mixed.
are, are not

Conclusions

15. The mixture in Figure B _____ homogeneous.
is, is not
16. Clay water _____ a liquid solution.
is, is not

COMPLETING SENTENCES Complete the sentences with the choices below. One of these terms may be used twice.

liquid solutions	moving around	light
drop	is not	clay water
molecules	transparent	small in size

1. When we can look clearly through something we say it is _____.
2. _____ are transparent.
3. _____ is not transparent.
4. Clay water _____ a liquid solution.
5. The parts of a liquid solution are the size of _____.
6. The molecules of a liquid solution do not block _____.
7. To "settle out" means to _____.
8. The parts of _____ do not settle out.
9. Liquid solutions do not settle out because the parts are too _____.
10. The molecules in liquid solutions are always _____.

WHICH IS HOMOGENEOUS?

The dots stand for copper sulfate molecules. The liquid is water.

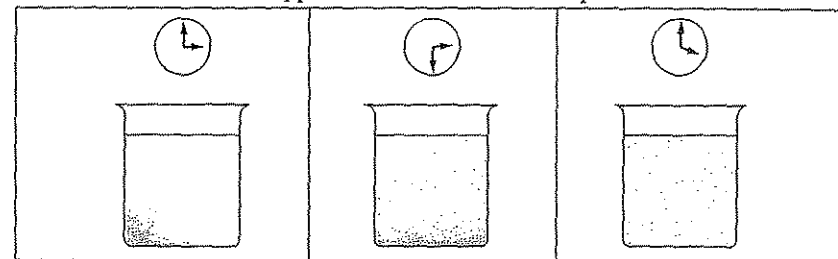


Figure C

Figure D

Figure E

1. Which figure shows a homogeneous mixture? _____
2. Which figure shows a liquid solution? _____
3. a) The mixtures in Figures _____ and _____ are not liquid solutions.
b) They are not liquid solutions because they _____ homogeneous.
are, are not
4. a) The mixtures that are not liquid solutions _____ become liquid solutions.
could, could not
b) They would be solutions if all the _____ dissolved, and spread out evenly.
solute, solvent
5. Think about this: What would you do to make the mixtures that are not homogeneous, become homogeneous fast?

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------|--|
| 1. _____ molecule | a) evenly mixed |
| 2. _____ homogeneous | b) drop |
| 3. _____ settle out | c) tiny part of matter |
| 4. _____ properties | d) clear |
| 5. _____ transparent | e) things that tell us how a kind of matter looks and acts |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
FALSE Write F if the sentence is false.

1. _____ Anything we can see through clearly is transparent.
2. _____ Every mixture is homogeneous.
3. _____ Sand becomes the size of molecules when it is in water.
4. _____ Liquid solutions are transparent.
5. _____ Muddy water is transparent.
6. _____ Muddy water settles out.
7. _____ The parts of liquids are the size of molecules.
8. _____ Salt water is a liquid solution.
9. _____ Liquid solutions settle out.
10. _____ The molecules of solutions are always moving around.

REACHING OUT

Transparent, translucent, and opaque are three words that have to do with light. Give a definition of each word in the spaces below. (You may use a dictionary.) Next to each definition give an example of each.

Transparent _____

Translucent _____

Opaque _____

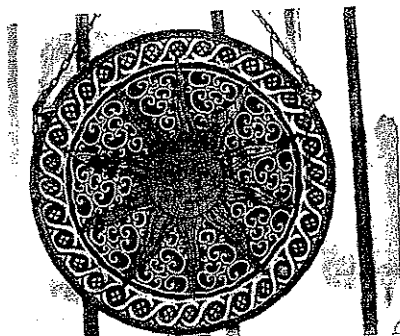


Figure F

WHAT DO WE CALL THE STRENGTHS OF LIQUID SOLUTIONS?

6

dilute: weak

concentrated: strong

saturated: having so much solute that no more can dissolve

AIM | What do we call the 6 | strengths of liquid solutions?

Some people like strong coffee. Others like it weak.

What makes coffee strong or weak? You know that if you add more coffee it becomes stronger. If you add more water, it becomes weaker.

A cup of coffee is like any liquid solution. It comes in many strengths.

We use these terms to describe how strong a liquid solution is:

- (a) dilute [die LOOT]
- (b) concentrated [KON sen tray tid]
- (c) saturated [SACH uh ray tid]

DILUTE A dilute solution is a weak solution. It has very little solute dissolved in the solvent.

CONCENTRATED A concentrated solution is a strong solution. It has more solute dissolved in it than a dilute solution has.

SATURATED A saturated solution is an extra-strong solution. It has so much solute that no more can dissolve. If we tried to add more solute, it would just drop to the bottom. More solute would dissolve only if the mixture were heated.

We can change the strength of a liquid solution. We do this by changing the amount of solute or solvent.

Terms like "dilute" and "concentrated" help us compare solutions.

HOW STRONG IS THE SOLUTION?

A cup of instant tea is a liquid solution.

Two different cups of tea are shown in Figures A and B. Study them. Then fill in the blanks.



Figure A

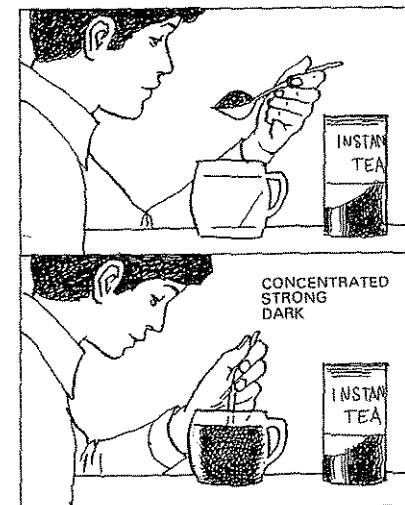


Figure B

- The instant tea _____ dissolve.
does, does not
- A cup of tea _____ a liquid solution.
is, is not
- In both solutions the solute is the _____.
tea, water
- In both solutions the solvent is the _____.
tea, water
- The cup of tea in Figure A has _____ of solute compared to the solution in Figure B.
a lot, a little bit
- The solution in Figure A is _____ than the solution in Figure B.
stronger, weaker
- The solution in Figure A is _____ than the solution in Figure B.
more concentrated, more dilute
- The solution in Figure B _____ have the same kind of solute and solvent as Figure A.
does, does not

9. The amount of solvent is _____ in both solutions.
the same, different
10. The amount of solute is _____ in both solutions.
the same, different
11. There is _____ solute in Figure B.
more, less
12. This solution is _____ than the solution in Figure A.
stronger, weaker
13. This solution is _____ than the solution in Figure A.
more concentrated, more dilute

COLOR AND STRENGTH OF SOLUTIONS

Sometimes, color tells us about the strength of a solution. The darker the color, the stronger the solution. The lighter the color, the weaker the solution. We can use color only when we compare *similar* solutions.

Of Figures A and B on page 35:

1. which figure shows a darker solution? _____
2. which figure shows a lighter solution? _____
3. which solution is stronger? _____
4. which solution is weaker? _____
5. Why can color help us compare the strengths of these mixtures? _____

COMPARING CONCENTRATIONS

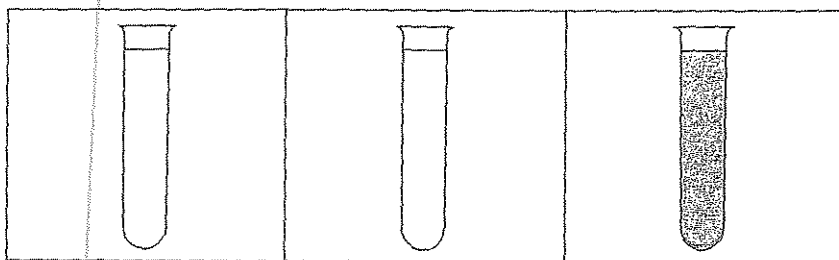


Figure C

Figure D

Figure E

Look at Figures C, D, and E. Each test tube contains a liquid solution. The kind of solute and solvent is the same in each.

1. Which is the strongest? _____
2. Which is the weakest? _____
3. Which has the most solute? _____
4. Which has the least solute? _____
5. Which one is closest to being saturated? _____

A SATURATED SOLUTION

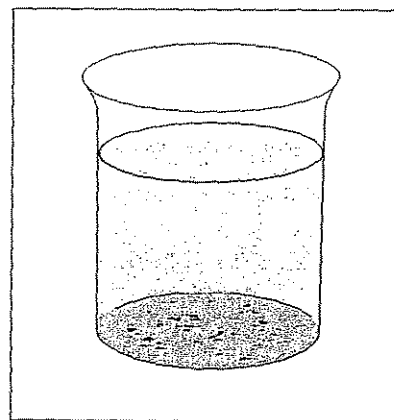


Figure F

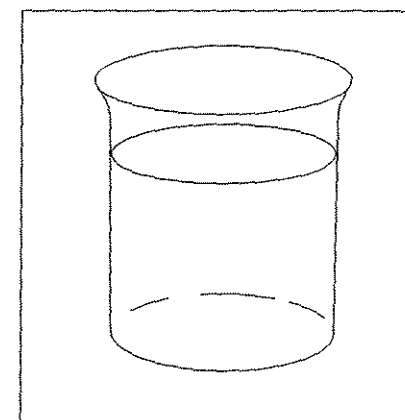


Figure G

Beakers F and G contain liquid solutions. The kind of solute and solvent is the same in each. Some additional solute has been added to each. Both mixtures have been stirred well.

1. Which is not saturated? _____
2. a) Which one is saturated? _____
b) How do you know? _____
3. Take a guess! How can we make the extra solute dissolve? _____

COMPLETING SENTENCES

Complete the sentences with the choices below.

lighter
very little
color
dilute

strengths
raising the temperature
concentrated

saturated
a lot
darker

- Liquid solutions come in different _____.
- A weak solution is called _____.
- A strong solution is called _____.
- Dilute solutions have _____ solute.
- Concentrated solutions have _____ of solute.
- A solution that can dissolve no more solute is called _____.
- We can make a saturated solution dissolve more solute by _____.
- Sometimes we can use _____ to compare the strengths of solutions.
- In comparing strength by color, the _____ the color, the stronger the solution.
- In comparing strength by color, the _____ the color, the weaker the solution.

FILL IN THE CHART

Put a check (✓) in the correct box.

	Solution becomes stronger.	Solution becomes weaker.
Add more solute.		
Add more solvent.		
Take away some solvent (this can be done by boiling).		

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------------------|---|
| 1. _____ dilute solution | a) extra solvent does not dissolve |
| 2. _____ concentrated solution | b) more solute dissolves |
| 3. _____ saturated solution | c) strong solution |
| 4. _____ raising the temperature | d) sometimes used to compare solution strengths |
| 5. _____ color | e) weak solution |

WORD SEARCH

The words in this list are hidden in the groups of letters. Try to find each word. Draw a line around each word. The spelling may go in any direction: up-and-down, across, or diagonally.

MOLECULE
SOLUTE
SOLVENT
DILUTE
SOLUBLE
GAS
DISSOLVE
SOLID
MIXTURE
LIQUID
MISCIBLE
SATURATE

Y	M	I	X	T	U	R	E	D	C
R	S	O	L	U	T	E	U	I	L
A	O	S	L	I	D	V	N	S	O
G	L	T	N	E	V	L	O	S	S
E	U	D	M	P	C	S	L	O	E
T	B	R	I	T	X	U	E	L	L
A	L	U	L	L	S	D	L	V	B
R	E	S	E	O	U	A	M	E	I
U	D	O	A	B	E	T	A	P	C
T	D	L	Q	G	I	Z	E	R	S
A	U	I	L	E	S	L	I	E	I
S	Q	D	I	U	Q	I	L	A	M

REACHING OUT

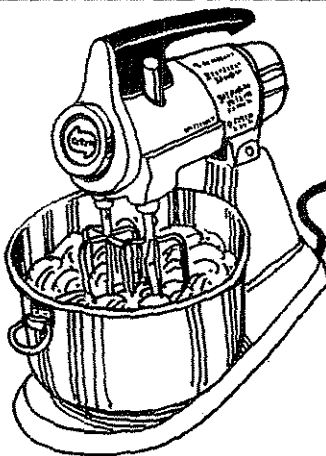
When could you not use color to compare the strengths of similar solutions?



Figure H

HOW CAN WE MAKE SOLID SOLUTES DISSOLVE FASTER?

7





ways of making solutes dissolve faster:

- stirring
- breaking up pieces
- heating

AIM | How can we make solid 7 | solutes dissolve faster?

What do you do after you add sugar to a drink? You stir. But why? You stir because you know that mixing makes sugar dissolve faster.

Stirring makes any solute dissolve faster.

Now here's another question. Which will dissolve faster, a lump of sugar or small grains of sugar? You know from experience that the smaller the pieces the faster it will dissolve.

Now let's tackle another question. Which will dissolve sugar faster, cold water or hot water?

From your experience you know that solutes dissolve faster in hot water.

There are three ways to make solids dissolve faster:

- Stir the mixture.
- Break the solute into smaller pieces.
- Heat the mixture.

(You probably know these ways from experience. But you probably have not thought about it in this way.)

Doing any one of these things makes a solute dissolve faster. Doing two or all three dissolves the solute much faster.

TRY THESE EXPERIMENTS YOURSELF

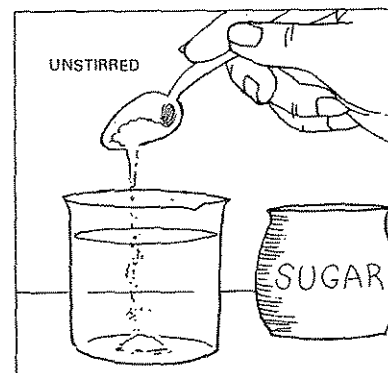


Figure A

Pour some granulated sugar into a glass of warm water. Do not stir.

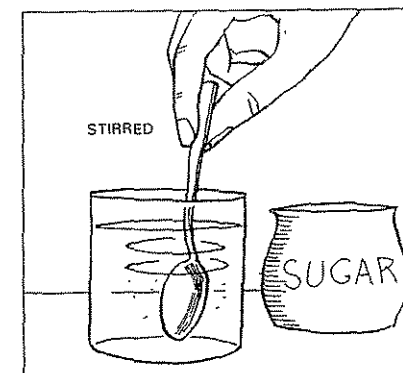


Figure B

Pour the same amount of granulated sugar into another glass of warm water. Then stir.

Notice how fast the sugar dissolves in each glass.

1. Stirring makes a solute dissolve _____ faster, slower.

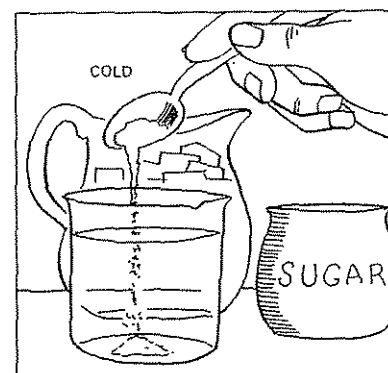


Figure C

Pour some granulated sugar into cold water. Do not stir.

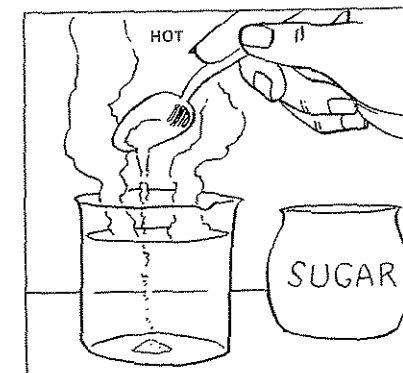


Figure D

Pour some granulated sugar into hot water. Do not stir.

Notice how fast the sugar dissolves in each beaker.

- A solute dissolves faster in a _____ solvent.
hot, cold
- A solute dissolves slower in a _____ solvent.
hot, cold
- Heat makes a solute dissolve _____.
slower, faster

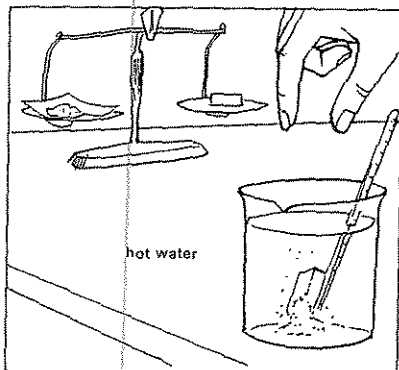


Figure E

Put a lump of sugar into a glass of hot water. Do not stir.

Notice how fast the sugar dissolves.

- Big pieces dissolve _____ than small pieces.
slower, faster
- Small pieces dissolve _____ than large pieces.
slower, faster
- Crushing makes solutes dissolve _____.
slower, faster

FILL IN Fill in the correct answer for each of the following sentences.
THE BLANKS

- The two main parts of any liquid solution are the _____ and the _____.
- The liquid part of a solution is called the _____.

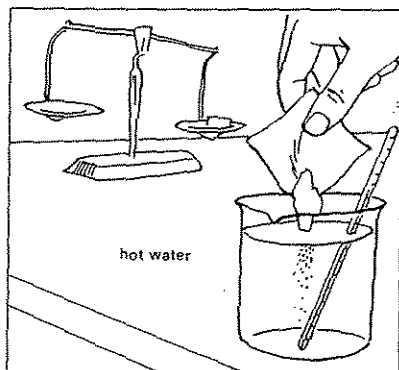


Figure F

Pour one teaspoon of granulated sugar into a glass of hot water. Do not stir.

- The part of a solution that mixes into the liquid is called the _____.
- Three ways we can make a solid solute dissolve faster are:
_____, _____, and _____.

FILL IN Put a check (✓) in the correct box.
THE CHART

If you ...	then the solute dissolves	
	faster.	slower.
1. make the pieces larger,		
2. make the pieces smaller,		
3. stir,		
4. do not stir,		
5. heat the solvent,		
6. do not heat the solvent,		

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

- _____ Stirring moves things around.
- _____ Crushing makes things larger.
- _____ Heat lowers temperature.
- _____ Stirring makes solutes dissolve faster.
- _____ Small pieces of solute dissolve slower than big pieces.
- _____ Heat makes solutes dissolve faster.

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. NEAHIGT _____
2. TARSEF _____
3. RIST _____
4. SCURH _____
5. SLEDSIVO _____

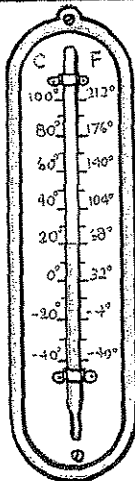
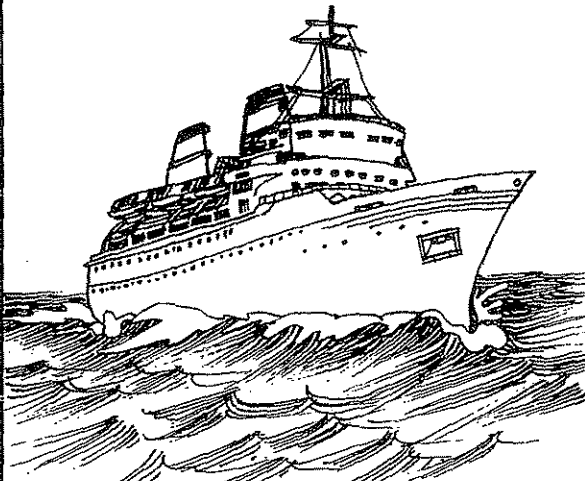
REACHING OUT

You put a piece of glass in water. It does not dissolve. You then crush it into tiny pieces.

Will the pieces dissolve? _____ Explain. _____

WHAT HAPPENS TO WATER WHEN IT IS HEATED?

8

	
	water vapor: water in the gas state boiling point: the temperature at which a particular liquid changes to a gas evaporate: to change from a liquid to a gas

AIM | What happens to water 8 | when it is heated?

Brrrr. . . Did you ever take a bath in cold water? Few of us have. Almost everyone bathes in hot water.

Heated water is very important. We use it in many ways—for cleaning—for cooking. Some homes are heated by hot water. Doctors use boiling water to kill germs on instruments. The steam from boiling water runs ocean liners and navy ships—even submarines.

What happens when water is heated? Follow what happens step-by-step. As you read, check with the Figure A.

- (1) When water is heated, its temperature rises (a).
- (2) At first you see tiny bubbles. They form on the sides and bottom of the container (b). They are air bubbles. They had been dissolved in the water. The heat is forcing them out of the water.
- (3) The temperature keeps rising as you keep heating the water.

When the temperature reaches 100°C (212°F), you see large bubbles. They rise quickly from the bottom of the water (c). These bubbles tell us that the water is boiling.

The bubbles are water vapor—water that has changed to a gas. The water evaporates [ee VAP uh rates]—the liquid changes to a gas. The gas escapes into the air. First the vapor is hot, invisible steam. It quickly changes to a fine cloud of tiny drops of liquid water. It is this fine cloud that most people call steam (d).

- (4) The water keeps boiling. But its temperature does not rise any higher. It stays at 100°C .

Unless something special happens, plain water does not get hotter than 100°C . Adding more heat just makes the water evaporate more rapidly. Soon all the water boils away.

WHEN WATER IS HEATED

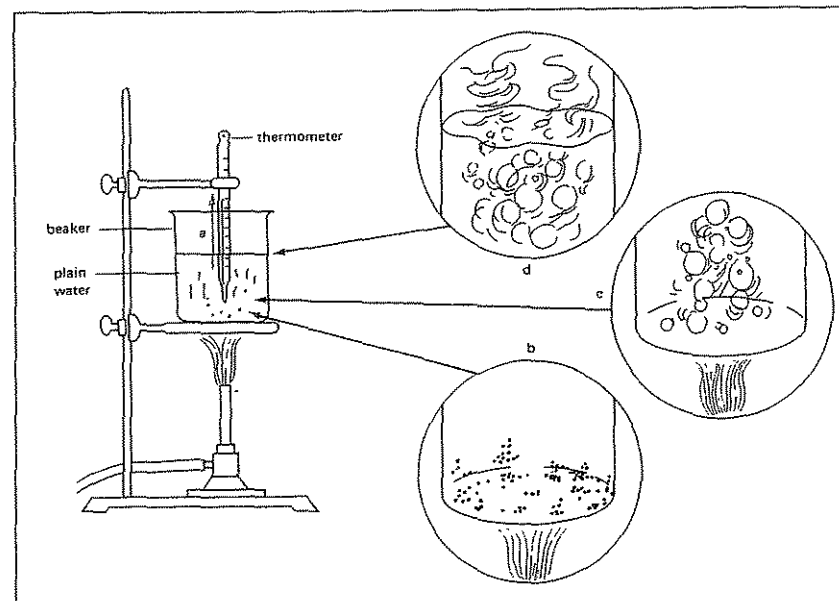


Figure A

See for yourself what happens to water when it is heated.

What You Need ringstand and clamp
Pyrex beaker
plain water
thermometer (F° & C°)
Bunsen burner
watch or clock

Set up the materials (Figure B).

- What To Do**
1. Take the temperature of the water before it is heated. Write it down on the chart on the next page.
 2. Light the flame under the beaker. Take the water temperature again at the times listed on the chart. Write down the temperature each time.

During all this time watch the water. See what happens. (Notice the water level too!)

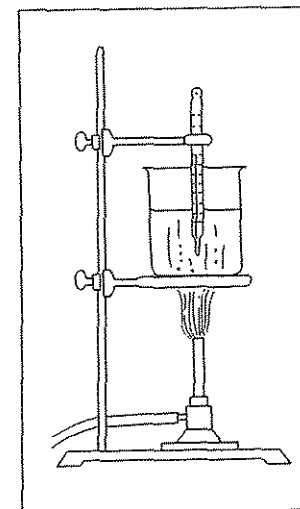


Figure B

Before Heating		Temperature
During Heating	1 minute	
	2 minutes	
	3 minutes	
	at boiling	
	1 minute after boiling	
	2 minutes after boiling	
	3 minutes after boiling	

What You Saw and Learned

- What happened to the temperature of water when it was heated? _____
- At what temperature did the water boil? _____°C
 - This is the same as _____°F.
- How did you know that the water was boiling? (What did you see?) _____

- You kept the water boiling for three minutes. Did the water get any hotter while boiling? _____
 - What does this prove about water? _____
- What happened to the water level as the water kept boiling? _____
 - Why did this happen? _____
- What would happen to the water if you were to keep the water boiling? _____

- Think back to when the water was starting to heat up.
 - Did you notice small bubbles? _____
 - What were these bubbles? _____
 - What kind of mixture does this prove tap water is? _____

TRY THIS AT HOME

- Fill a glass with cold tap water.
- Let it stand overnight.
- Describe what you see the next day.

- Draw a picture of what you see on Figure C.

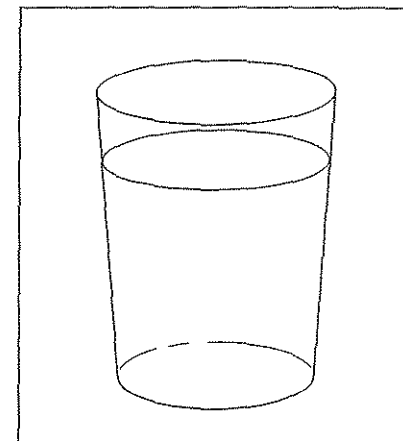


Figure C

COMPLETING SENTENCES

Complete the sentences with the choices below.

rises
water vapor
liquid
does not

liquid solution
100°C or 212°F
thermometer

large bubbles
dissolved air
gas

- A _____ measures temperature.
- When matter is heated, its temperature _____.
- The water you drink is in the _____ state.
- Tiny bubbles form soon after water is heated. They are bubbles of _____.
- The tiny air bubbles prove that water is a _____.
- When water boils, _____ quickly rise to the surface.
- The large bubbles are _____.
- Water vapor is water in the _____ state.
- Tap water boils when its temperature reaches _____.
- If we keep on boiling water, its temperature _____ rise any higher.

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Tap water has air dissolved in it.
2. _____ Water can hold more dissolved air when it is heated.
3. _____ A thermometer tells us how long something is heated.
4. _____ Heat raises temperature.
5. _____ Tiny bubbles on the side of a pot of water means that the water is boiling.
6. _____ Plain water boils at 212°C .
7. _____ 212°F is the same as 100°C .
8. _____ If water boils for a long time, its temperature rises above 100°C .
9. _____ Boiled water has gases dissolved in it.
10. _____ Water is always evaporating.
11. _____ Water evaporates faster when it is heated.
12. _____ Water evaporates fastest when it boils.
13. _____ You can see water vapor.
14. _____ There is water in the air.

REACHING OUT

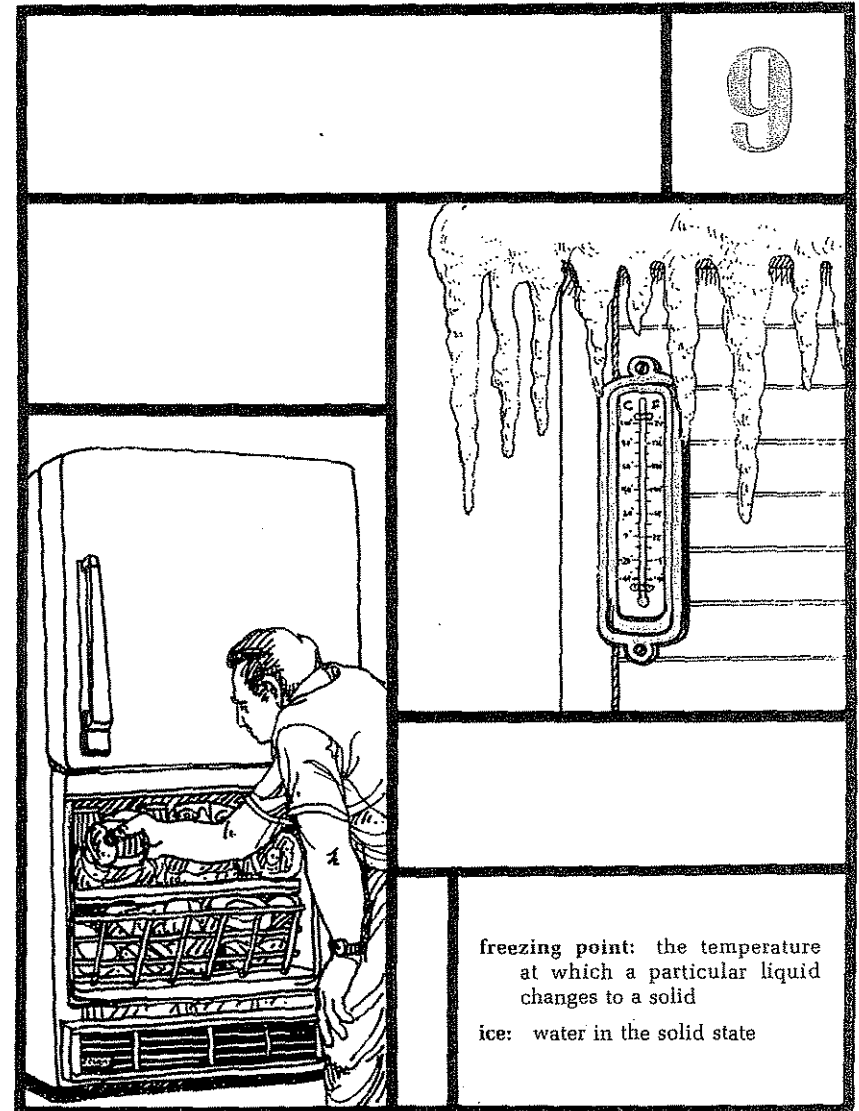
What happens to the water vapor that goes into the air?



Figure D

WHAT HAPPENS TO WATER WHEN IT COOLS?

9



freezing point: the temperature at which a particular liquid changes to a solid

ice: water in the solid state

AIM What happens to water 9 when it cools?

Can you walk on water? Sure you can! Just step onto ice. Ice is water. It is water in the solid state. But it is still water— H_2O .

Water can be a liquid, or a solid, or a gas. It all depends on the temperature.

You have already learned that water changes to a gas when it takes in enough heat.

What happens when water loses heat?

When water loses heat, its temperature drops. It becomes colder and colder. When the water loses enough heat, it changes to a solid called ice. We say it freezes.

Plain water freezes at $0^{\circ}C$ ($32^{\circ}F$). This is its freezing point. Other liquids freeze at different temperatures. When water temperature falls to $0^{\circ}C$, it stays liquid for a short time. Then it changes to a solid—a bit at a time.

The temperature of ice keeps dropping as the air temperature around it becomes colder. This means that some ice is colder than other ice.

DOES ICE HAVE HEAT?

Yes, ice does have heat!

All matter has heat. Some matter just has more heat than other matter.

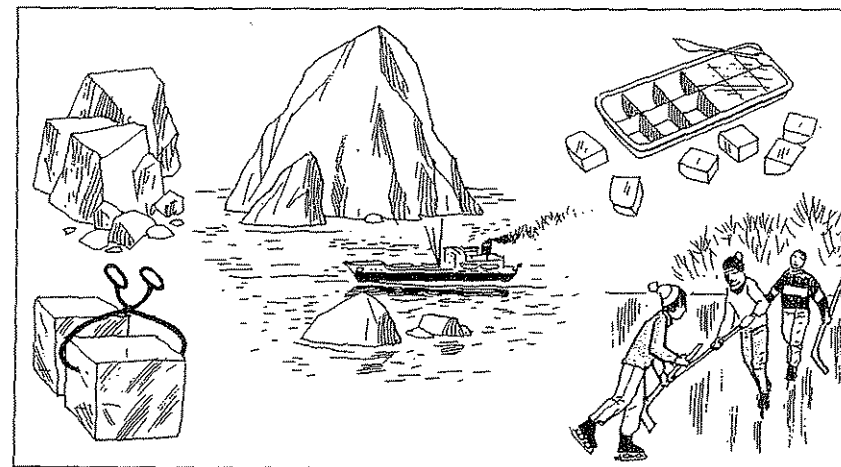


Figure A

Heat moves from one place to another.

Heat that is lost in one place goes somewhere else.

As matter becomes warmer, it gains heat.

As matter becomes cooler, it loses heat.

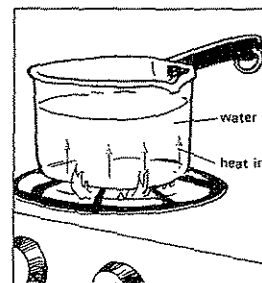


Figure B

When liquid water becomes warmer, it gains heat.

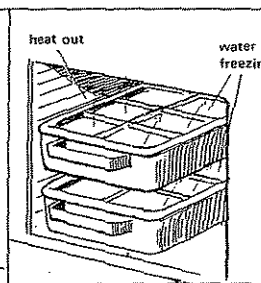


Figure C

When liquid water freezes, it loses heat.

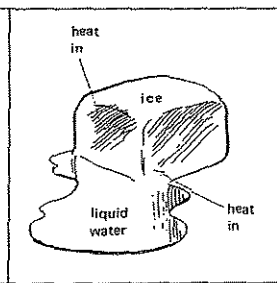


Figure D

When ice changes to liquid water, it gains heat.

WHEN WATER FREEZES

This experiment can be done at home.

Purpose: To find the freezing temperature of water

What You Need small plastic cup half full with water
thermometer that goes below 0°C (32°F)
refrigerator freezer

What To Do

1. Check the water's temperature before placing it in the freezer. Write it down on the chart below.
2. Keep the thermometer in the cup. Place the cup into your freezer.
3. Check the temperature every 15 minutes. Write down the temperature each time. Do this until all the water changes to ice.
4. Check the temperature in the morning. Write it down on the chart.



Figure E

	Time	Temperature	State of the Water. (Liquid, Part Liquid/ Part Solid, All Solid)
	Start		All Liquid
Outside the Freezer	15 min.		
	30 min.		
	45 min.		
	1 hour		
	1 hr., 15 min.		
	1 hr., 30 min.		
	2 hrs.		
	2 hrs., 30 min.		
	next morning		
Inside the Freezer	15 min.		
	30 min.		
	45 min.		
	1 hour		
	1 hr., 15 min.		
	1 hr., 30 min.		
	2 hrs.		
	2 hrs., 30 min.		
	next morning		

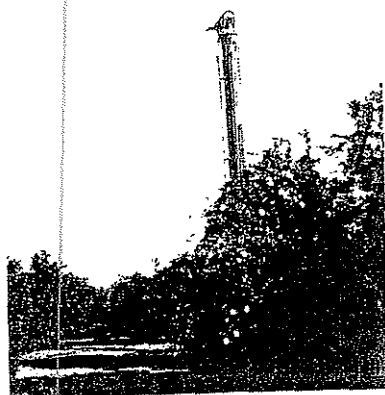
What You Saw and Learned

1. While the water was in the freezer, the temperature went _____
up, down
2. When the temperature just reached 0°C (32°F), the water _____
was still a liquid, changed to ice
3. The water then changed to ice _____
all at once, a little at a time
4. What was the temperature of the water as it was changing to ice? _____
5. What was the temperature when all the water changed to ice? _____
6. a) What was the temperature of the ice in the morning? _____
b) What does this show about the temperature of water? _____
7. When water freezes, it _____ heat.
takes in, gives off

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Everything has heat.
2. _____ Heat can be taken in and given off.
3. _____ Something that takes in heat gets colder.
4. _____ Heat that is given off by one thing is taken in by something else.
5. _____ Water is always a liquid.
6. _____ Water can be a gas.
7. _____ Water can be a solid.
8. _____ Water vapor is water in the solid state.
9. _____ Water freezes at 0°C .
10. _____ 0°C and 32°F stand for the same temperature.

KEEPING FRUIT FROM FREEZING UP WITH ANTIFREEZE



FROST BUGS BEWARE!

Citrus fruit, like grapefruit and oranges, grow in warm climates. Most of our nation's juice oranges grow in southern Florida. The temperature there usually stays above freezing—even during the winter months. However, sometimes, a cold spell may drop the temperature to below freezing. Frost can damage or destroy citrus crops. The loss can run to many millions of dollars. In the end, the consumer pays for it in higher prices.

Only a small number of grove owners try to protect their fruit from freezing. Some use huge propellers. The whirling blades blow warm Air that had risen from the ground onto the trees. Other grove

owners use oil-burning smudge pots. But oil is expensive and polluting.

Steve Lindow of California, is a specialist in plant disorders. He is trying to develop an easy and inexpensive way to prevent frost damage.

Lindow has studied the process of freezing. Water, you know, freezes at 0°C (32°F). However, for water to freeze at this temperature, the water must have a "starter"—a right kind of speck of matter. Ice forms around this speck. If there is no speck, the water will freeze at a temperature lower than 0°C .

Dew will freeze on most kinds of plants at 0°C . Lindow discovered that on evergreens, dew freezes at a lower temperature. Why the difference? Research led to the discovery of the frost bugs.

On most plants, ice-forming specks are two kinds of bacteria. *P. syringia*, and *E. herbicola*. These bacteria do not live on evergreens.

Lindow saw a way of protecting crops from freezing down to at least -5°C . How? Get rid of the frost bugs! But how?

Farmers already use bactericides (bacteria-killing chemicals) to control plant diseases. Why not use them to kill the frost bugs and thus prevent frost? Nationwide testing of Lindow's approach is underway.

Lindow advises growers to use bactericides well in advance of cold weather. It seems that ice crystals form around dead bacteria as well as live ones. If treatment starts early enough, wind and rain will remove the dead bacteria.

Lindow says this approach will not permit citrus and other warm-climate crops to grow in the colder northern states. But it can save crops in areas that are generally warm, but that sometimes experience frost.

DO DISSOLVED SOLUTES CHANGE THE FREEZING AND BOILING POINTS OF WATER?

10



antifreeze: a solution added to car radiators

AIM 10 Do dissolved solutes change the freezing and boiling points of water?

Most automobile engines are cooled with water. In the wintertime it is very cold in most parts of the country. If the water freezes, it can ruin the engine.

Car owners add antifreeze to the car's water. This prevents the water from changing to ice. The same antifreeze also protects the engine from boiling over in the hot summer.

How does antifreeze work?

Antifreeze is a liquid solution. It has solutes dissolved in a liquid.

Certain (not all) dissolved solutes change the boiling point and freezing point of water.

DISSOLVED SOLUTES MAKE IT HARDER FOR WATER TO FREEZE AND TO BOIL.

This means that the water needs more cold to freeze and more heat to boil. The water freezes at a temperature lower than 0°C (32°F). It boils at a temperature higher than 100°C (212°F).

Adding more solutes lowers the freezing temperature and raises the boiling temperature even more. BUT THERE IS A LIMIT. After a certain amount of solute has been added, no more changes take place.

SOLUTES CHANGE BOILING AND FREEZING POINTS

Certain solutes

raise the boiling temperature, and lower the freezing temperature of water.

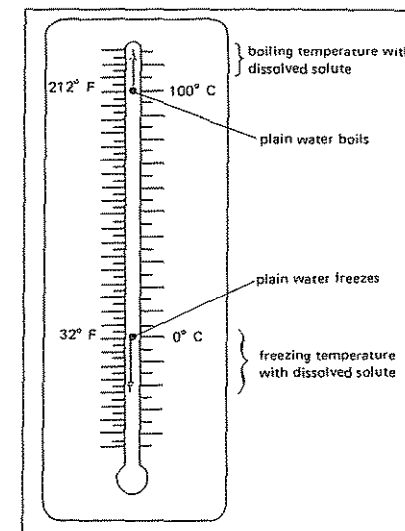


Figure A

HOW DOES SALT CHANGE THE BOILING POINT OF WATER?

Purpose: To show how adding salt changes the boiling point of water

What To Use 2 Pyrex beakers
2 ring stands and clamps
2 thermometers
water
salt
2 Bunsen burners

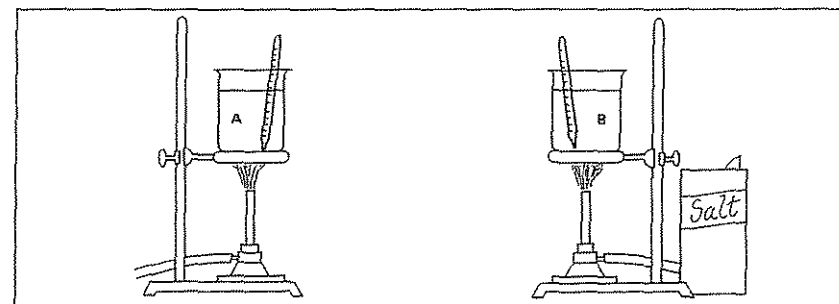


Figure B

What To Do

1. Fill both beakers half full with water. Label one beaker A and the other B.
2. Stir a teaspoon of salt into beaker B only.
3. Set the beakers on the ringstands and place the thermometers in the water. Light the burners.
4. Observe the temperature at which the water boils in each beaker.

Put your observations on the chart below.

	Boiling Point
PLAIN TAP WATER	
SALT WATER	

What You Saw and Learned

1. The tap water boiled at _____ °C, _____ °F.
2. The salt water boiled at _____ °C, _____ °F.
3. The salt water boiled at a _____ temperature than the tap water.
higher, lower
4. Water boils at a _____ temperature when a solute is added.
higher, lower
5. Is salt water a solution? _____
6. Which part is the solute? _____
7. Which part is the solvent? _____
8. Do all dissolved solutes raise the boiling point of water? _____

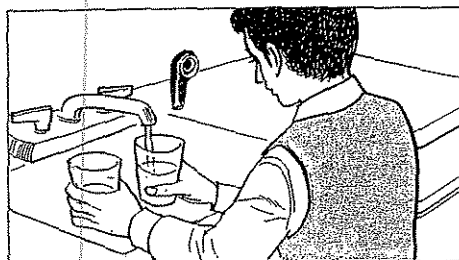


Figure C

TRY THIS AT HOME

Get two small, plastic containers of the same size. Fill them half full with tap water.

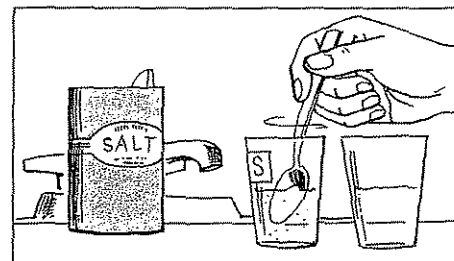


Figure D

Dissolve a tablespoon of salt into one of the containers.

Label this container S.



Figure E

Place the containers in your freezer.

Check them every half hour.

Which one freezes first?

What You Saw and Learned

1. The plain tap water froze _____ than the salt water.
faster, slower
2. The salt water froze _____ than the plain tap water.
faster, slower
3. Dissolved salt makes water _____ to freeze.
easier, more difficult

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

Adding solutes to water:

1. _____ makes the water more difficult to freeze.
2. _____ lowers the freezing point.
3. _____ raises the freezing point.
4. _____ makes it easier to boil.
5. _____ raises the boiling point.
6. _____ lowers the boiling point.

FIND THE HIDDEN WORDS

TEMPERATURE has a total of eleven letters. If we take parts of this word or move some of the letters around, they make up other words. Some of the words you have learned in this book. How many of these hidden words in TEMPERATURE can you find?

TEMPERATURE

1. A drink served hot or iced (3 letters) _____
2. Water faucet (3 letters) _____
3. The opposite of false (4 letters) _____
4. Small rug near the door (3 letters) _____
5. Anything that has weight and takes up space (6 letters) _____

REACHING OUT

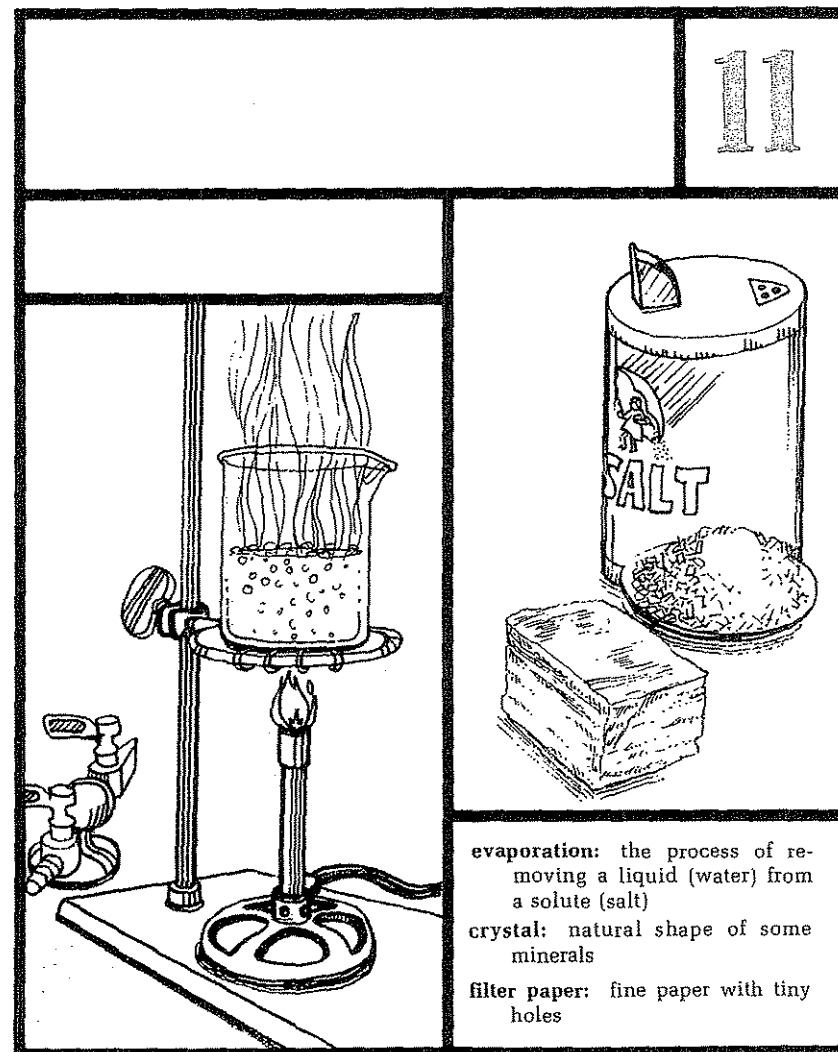
How could antifreeze have helped this situation? Explain. _____



Figure F

HOW CAN WE GET THE SOLUTE FROM A LIQUID SOLUTION?

11



AIM | How can we get the solute 11 | from a liquid solution?

Everybody knows that ocean water tastes salty. Ocean water tastes salty because there is salt dissolved in it—the same kind of salt you sprinkle on your food.

Sea water is a liquid solution. The water is the solvent. The salt is one of the solutes dissolved in it. How can you prove that sea water contains dissolved salt? Simple! Place some sea water into a shallow dish and let it stand for a few hours. Slowly the water evaporates. The water changes to a gas and goes into the air. The salt stays behind as a solid.

You can make this happen faster if you heat the water. Heat speeds evaporation.

Any liquid solution can be separated by evaporation. But remember—only the solid solute will remain. The solvent escapes into the air.

What happens if you pass salt water through filter paper? Does the filter paper trap the salt? The answer is no! A liquid solution cannot be separated by filtering.

This is because the parts of a liquid solution are the size of molecules. They are so tiny that they pass right through the holes of the filter paper. Filter paper holes are small—but molecules are much smaller.

HOW MUCH DISSOLVED SALT DOES THE OCEAN HAVE?

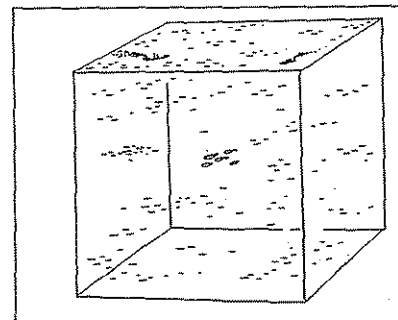


Figure A

The ocean has a huge amount of salt.

Just 2.5 cubic kilometers (1 cubic mile) of sea water has 109 million metric tons (120 million tons) of salt.

All the oceans together contain about 34 quadrillion (34,000,000,000,000,000) metric tons. That's a lot of salt!

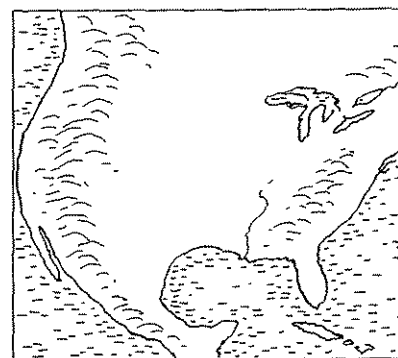


Figure B

This much salt (in solid form) would cover all of the United States with a layer about .6 meters (2 feet) thick.

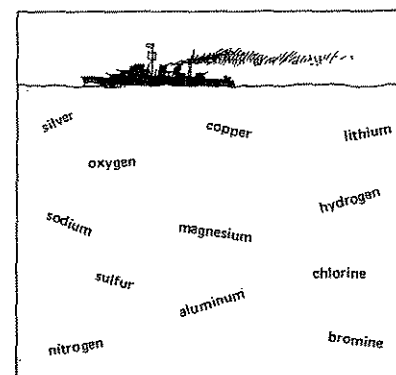


Figure C

The oceans have more than just salt. Sea water has enormous amounts of other substances too. In fact, every known element is found in sea water.

CRYSTALS

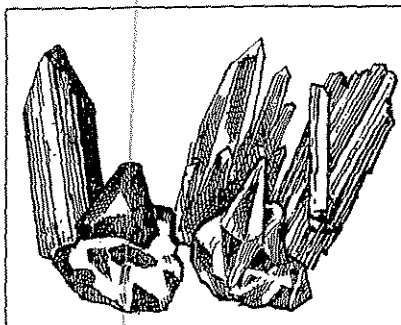


Figure D

Some of the many crystal forms

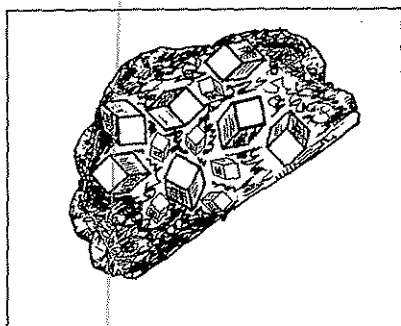


Figure E

Salt crystals

FILL IN THE BLANKS Fill in the correct answer for each of the following.

1. The most common solute found in the ocean is _____.
2. When a solute _____ up, it has a natural shape.
3. The natural shape of some solids is its _____ form.
4. Different solids have different _____ forms.

A solute may have a definite shape when it dries up. It is its natural shape.

We call this natural shape its crystal form.

There are many crystal forms. Figure D shows a few.

Different solids have different crystal forms.

Crystal form helps us to identify solids.

Salt crystals might look round to the naked eye. But they are not round.

This is what salt crystals look like through a microscope.

How would you describe their shape? _____

WHEN SALT WATER EVAPORATES

What You Need
salt
beaker
Petri dish
stirrer

See for yourself what happens when salt water evaporates. Figure F shows you what to do.

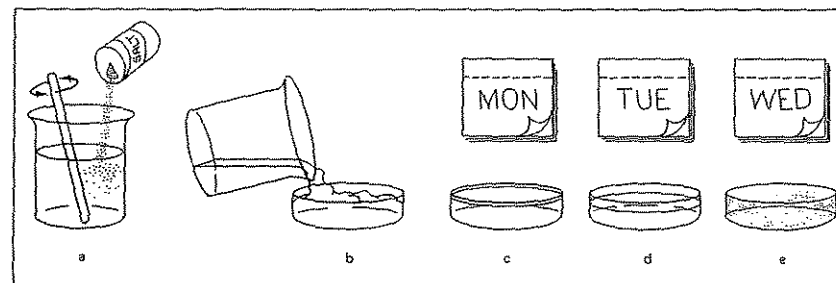


Figure F

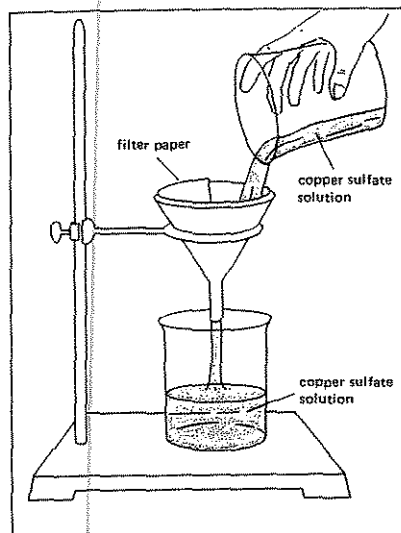
1. Did the salt and water form a solution? _____
2. In salt water, a) the solute is the _____
salt, water
b) the solvent is the _____
salt, water
3. Did the water from your dish evaporate? _____
4. Was anything left behind? _____
5. The _____ was left behind in its _____ form.
solute, solvent solid, liquid
6. Name the solid that was left behind. _____
7. Name the liquid that went into the air. _____

What You Learned

8. When salt water is left in an open dish, the _____ evaporates.
salt, water
9. In evaporation, a _____ changes to a _____.
gas, liquid gas, liquid
10. When a solution evaporates, we get back _____

_____ only the solute, only the solvent, both the solute and solvent

CAN FILTERING SEPARATE A SOLUTE FROM A SOLVENT?



What You Need 2 beakers
copper sulfate solution
funnel
filter paper
ring stand

What You Need To Know

Filter paper is like a very fine strainer. It has tiny holes. Things larger than the holes get trapped. Things smaller than the holes pass right through.

What To Do

Set up the materials as in Figure G. Pour in the solution.

Figure G

What You Saw and Learned

- The solute _____ left behind in the filter paper.
was, was not
- The solvent _____ left behind in the filter paper.
was, was not
- The solute particles are _____ than the holes in the filter paper.
larger, smaller
- The solvent particles are _____ than the holes in the filter paper.
larger, smaller
- A liquid solution _____ be separated by filtering.
can, cannot
- The parts of a liquid solution are _____
the size of molecules, larger than the size of molecules
- Filter paper holes are _____
the size of molecules, larger than the size of molecules

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used three times. One other word may be used twice.

filtering	larger	solvent
gas	heated	molecules
solute	crystal form	

- The parts of a liquid solution are the _____ and _____.
- The _____ is always a liquid.
- In evaporation, a liquid changes to a _____.
- When a liquid solution evaporates, only the _____ changes to a gas.
- The _____ stays behind in its solid form.
- Evaporation happens faster when a solution is _____.
- The natural shape of a solid is called its _____.
- The parts of a liquid solution are the size of _____.
- Filter paper holes are _____ than the size of molecules.
- Liquid solutions cannot be separated by _____.

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

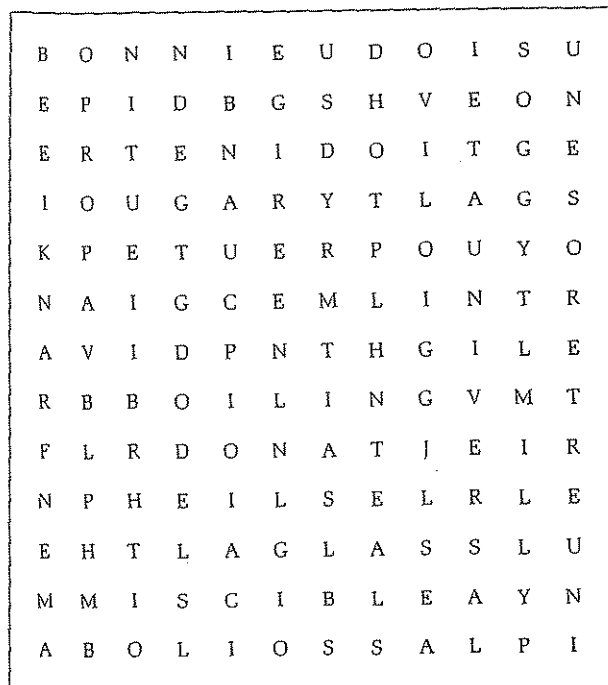
- _____ All solutes are solids.
- _____ You can see dissolved solids.
- _____ Evaporation changes a liquid to a gas.
- _____ Water can change to a gas.
- _____ Only heated liquids evaporate.
- _____ The natural shape of a solid is called its crystal form.
- _____ Filter paper is like a strainer.
- _____ The holes in filter paper are very tiny.
- _____ The holes in filter paper are smaller than molecules.
- _____ Filtering separates the parts of a liquid solution.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------|---|
| 1. _____ evaporation | a) speeds evaporation |
| 2. _____ heat | b) smaller than the holes in filter paper |
| 3. _____ molecules | c) natural shape of solids |
| 4. _____ filter paper | d) liquid changes to a gas |
| 5. _____ crystal form | e) has very tiny holes |

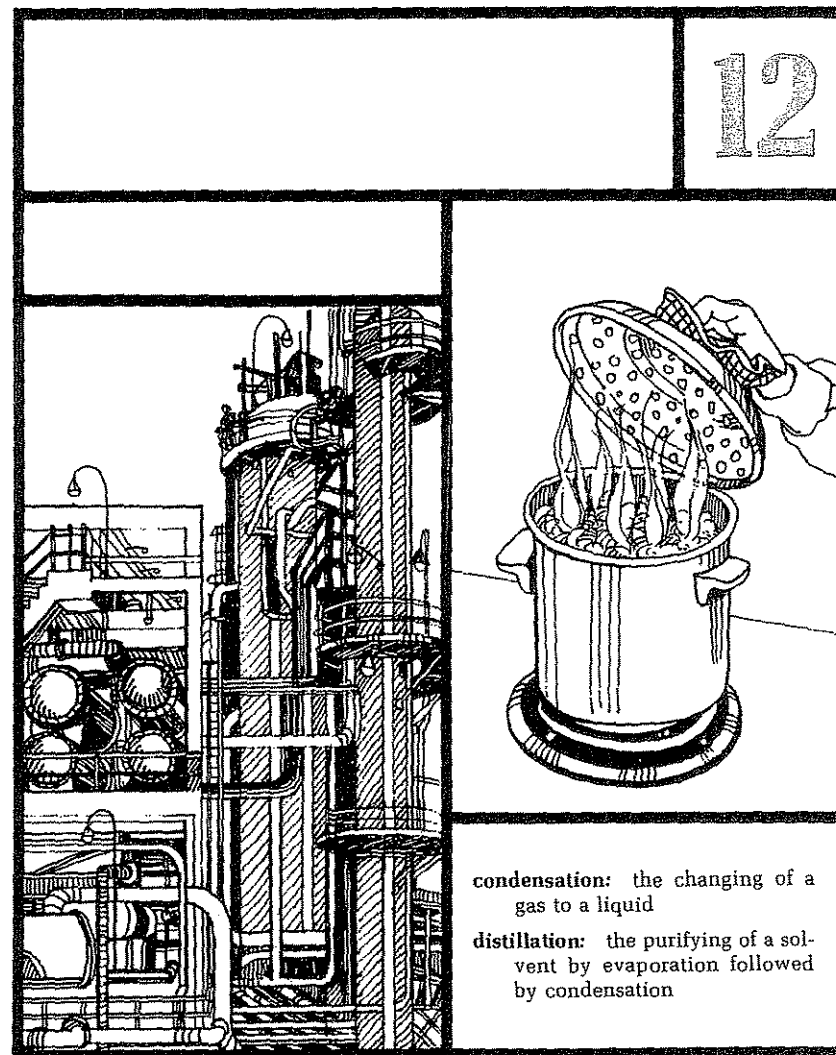
WORD SEARCH The words in this list are hidden in the groups of letters. Try to find each word. Draw a line around each word. The spelling may go in any direction: up-and-down, across, or diagonally.

SOLUTE
UNIVERSAL
IODINE
TINCTURE
MISCIBLE
PROPERTIES
BOILING
VAPOR
GLASS
LIGHT



HOW CAN WE GET THE SOLVENT FROM A LIQUID SOLUTION?

12



condensation: the changing of a gas to a liquid

distillation: the purifying of a solvent by evaporation followed by condensation

AIM 12 | How can we get the solvent from a liquid solution?

Have you cooked anything lately? Did you pick up the lid from the pot and find water droplets on the inside?

Where did the water come from? When the hot steam touched the cooler metal cover, the steam became water. This process is called *condensation* [kon den SAY shun].

Condensation can help us get the solvent from a liquid solution.

When we boil a solution, the solvent evaporates. We are left with the solute. But, if we trap the evaporated liquid, then we can condense it.

This process is called *distillation* [dis tu LAY shun]. There are two steps to distillation.

- The first step is evaporation. The liquid changes to a gas.
- The second step is condensation. The gas changes back to a liquid. We get a pure solvent without the solute.

Look at Figure A. It shows a small distillation unit. Follow the steps under Figure A. See what happens to a liquid solution when it is distilled.

A DISTILLATION UNIT

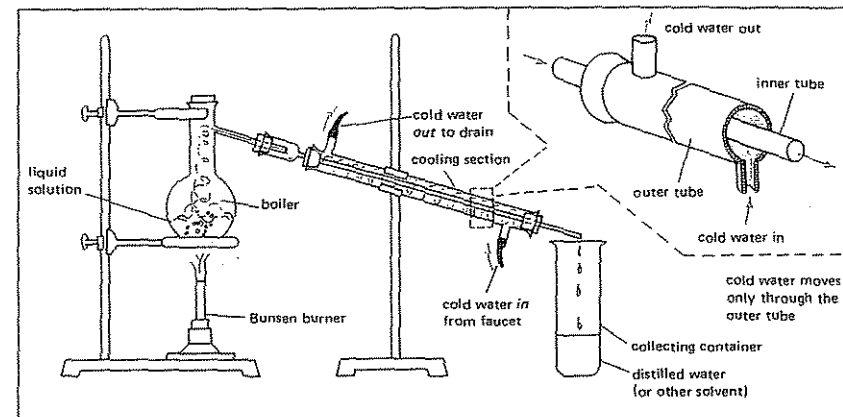


Figure A

What You Must Know

A distillation unit has two main parts: a boiler and a cooling section.

- In the boiler *evaporation* takes place.
- In the cooling section *condensation* takes place.

The cooling section is a "tube within a tube." Cold water flows in the outer tube. This cools the inner tube.

WHAT HAPPENS IN DISTILLATION?

Check with Figure A as you read.

1. The liquid solution is boiled in the boiler. The solvent evaporates. The solvent changes from a _____ to a gas (water vapor).
2. The vapor moves out of the boiler. It goes into the inner tube of the cooling section.
3. The cold water in the outer tube cools the vapor. This makes the vapor condense. The vapor changes from a _____ back to a liquid.
4. The liquid drips into a container. It is pure. It has been *distilled*. It has no solute in it.
5. What happens to the solute? The solute stays behind in the boiler. It is now dried up. It is in solid form.

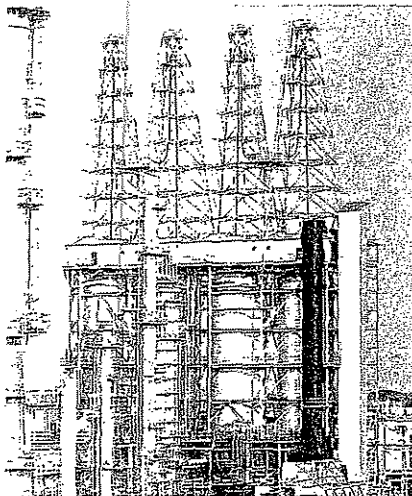


Figure B

Distillation is important in industry.

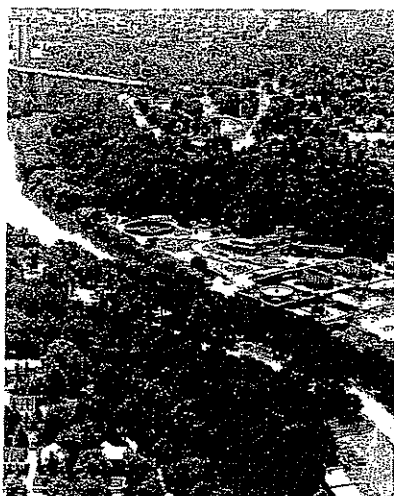


Figure C

Some places do not have enough good drinking water. It is either salty or polluted. Large distillation units usually make the water good and safe to drink.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------------------------|---------------------------------|
| 1. _____ evaporation | a) gets back only solute |
| 2. _____ distillation | b) steps in distillation |
| 3. _____ evaporation and condensation | c) speeds condensation |
| 4. _____ rise in temperature | d) gets back solute and solvent |
| 5. _____ cooling | e) speeds evaporation |

COMPLETING SENTENCES

Complete the sentences with the choices below. Four of these may be used twice.

liquid
drop
condensation

solute
distilled
distillation

rise
evaporation
gas

- Evaporation saves only the _____ of a liquid solution.
- _____ gets back both the solute and solvent from a liquid solution.
- The two steps of distillation are _____ and _____.
- The first step in distillation is _____.
- The second step in distillation is _____.
- In evaporation a _____ changes to a _____.
- In condensation a _____ changes to a _____.
- Evaporation is speeded by a _____ in temperature.
- Condensation takes place when there is a _____ in temperature.
- _____ water has no solutes in it.

TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

- _____ When a liquid solution evaporates, the solvent stays behind.
- _____ Distillation gets back solutes and solvents.
- _____ The first step in distillation is evaporation.
- _____ In evaporation, a gas turns to a liquid.
- _____ The second step in distillation is condensation.
- _____ In condensation, a gas changes to a liquid.
- _____ A rise in temperature speeds evaporation.
- _____ A rise in temperature speeds condensation.
- _____ All water is good to drink.
- _____ Distillation can make salty water good to drink.

IDENTIFY THE PARTS

Figure D shows a distillation unit. Identify the following parts by letter. You may use a letter more than once.

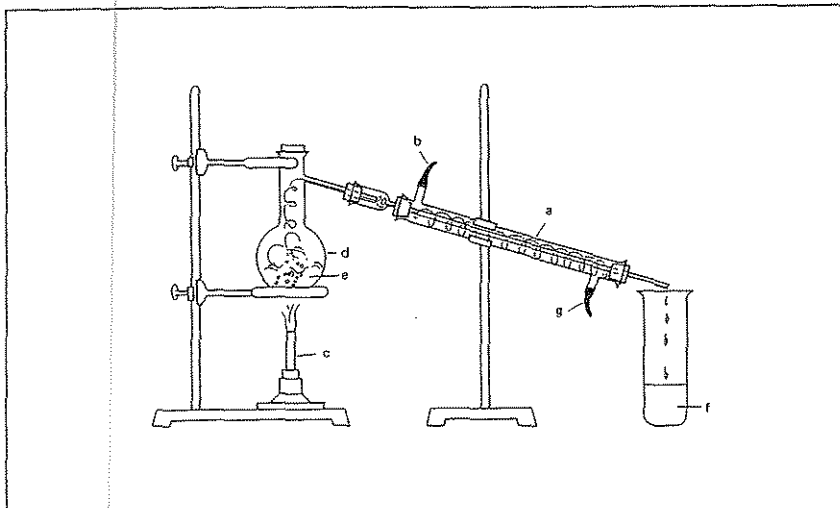
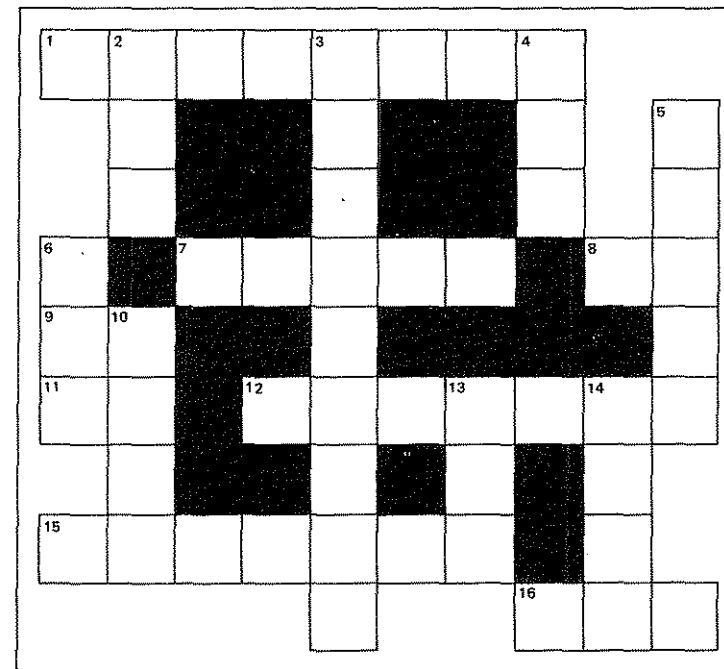


Figure D

1. Bunsen burner _____
2. boiler _____
3. cooling section _____
4. where cold water enters _____
5. where cold water leaves _____
6. liquid solution before distillation _____
7. where evaporation takes place _____
8. where condensation takes place _____
9. where the solvent changes to a vapor _____
10. where the vapor changes to a liquid _____
11. distilled solvent _____
12. the part where the solute stays behind _____

CROSSWORD PUZZLE

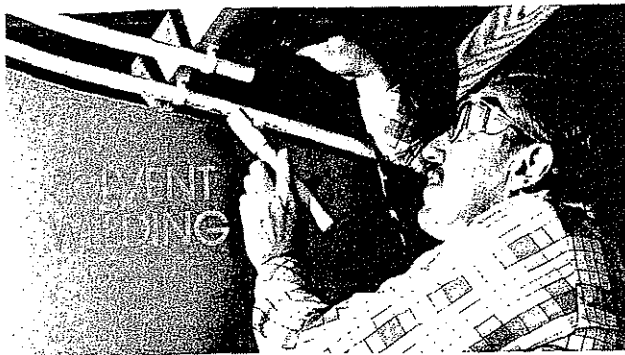


Across

1. To change from a gas to a liquid
7. Another name for a gas
8. Short for an American soldier
9. Right _____!
11. Self
12. What water does at 0°C
15. Natural shape of some solids
16. Eyelid infection

Down

2. Rowboat paddle
3. To change from a liquid to a gas
4. A sense organ
5. What water does at 100°C
6. A boy's name
10. Close by
13. Long snake-like fish
14. Compass direction



Solvents dissolve. They change solids into liquids; they separate molecules from one another. Solvents can also join. They bond materials.

Solvent joining can produce very strong bonds. In fact, it is also called solvent welding and has many uses. One of the most important uses is in plumbing.

In the past, only metal pipes carried fresh and waste water in homes and factories. Plastic pipes were forbidden. Modern chemistry has now developed very strong and non-toxic plastics. Durable and dependable plumbing pipes and fittings are made from these plastics. Furthermore, plastics do not corrode.

Unfortunately, old ideas are often slow to die. Committees decide local building rules, called codes. The codes state which materials may and may not be used in buildings. For many years, most committees would not accept the idea that plastic plumbing could be as good as metal plumbing. But times change and so do codes. Plumbing restrictions are being eased, especially for homes. This is especially good news for the do-it-yourself

plumber.

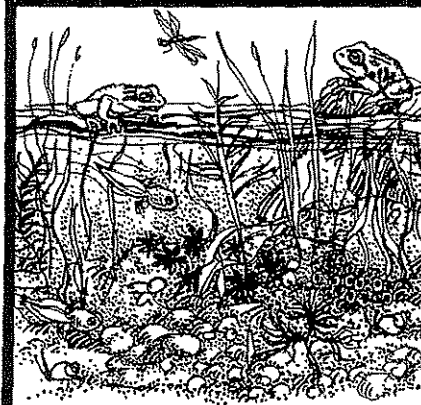
Copper pipes and fittings are usually joined by "sweat" soldering. This requires heat—either a flame or a soldering iron. Plastic plumbing requires no heat. It is safer, cheaper, and much easier to work with than metal plumbing.

Plastic-pipe joining (welding) requires only a saw, a knife, a brush, and, of course, a solvent cement. The cement is in a semi-liquid state. It consists of a plastic that is dissolved in one or more solvents. The plastic is of the same kind as the pipe that is to be joined.

To make a solvent-welded joint, you simply brush the solvent cement into the pipe and its fitting. Then you push them together. The solvent softens the walls of the pipe and fitting. Within twenty-four hours, the solvent evaporates. Only the plastic that was part of the joining cement remains. It joins to the pipe and its fitting. The joint is actually welded together. The parts cemented by solvent welding become one system. And if instructions have been followed carefully, there will be no leaks and no corrosion.

WHAT IS A SUSPENSION?

13



suspension: a mixture that settles out

sediment: material that settles to the bottom of its container; for example, clay, sand, pebbles, and rocks in a stream

AIM | What is a suspension?

13

Before you pour orange juice, you shake it. Before you spoon out vegetable soup, you stir it.

Orange juice and vegetable soup are mixtures. But they are not like liquid solutions. The parts of liquid solutions dissolve and do not settle. Mixtures like orange juice and vegetable soup do not dissolve. The parts do settle out.

Mixtures that do not dissolve and that do settle are called suspensions [suss PEN shunz].

You have many suspensions in your home. Salad dressing and fruit juices are suspensions. So is liquid shoe polish.

Look in your medicine cabinet. Some bottle labels may say "Shake well before using." These bottles contain suspensions. In fact, any mixture that you see settling or that needs mixing is a suspension.

Many common suspensions are made of solids and liquids. But a suspension can be made of solids and gases, too.

The parts of a suspension settle by weight. The heavy parts settle first. Then the lighter parts settle.

Now you know two important properties of suspensions:

(a) Suspensions do not dissolve.

(b) The parts of a suspension settle out. They separate into layers by weight.

You will study more properties of suspensions in the next Aim.

CLAY AND WATER

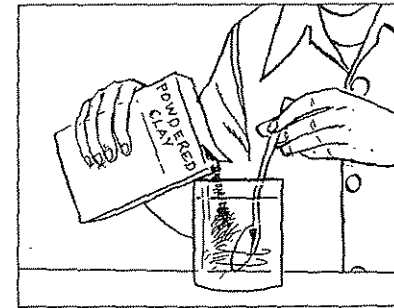


Figure A

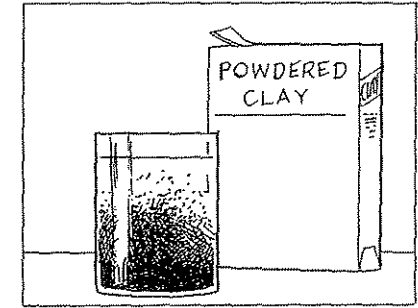


Figure B

TRY THIS!

Stir some powdered clay into a jar of water. Let it stand. Notice what happens.

1. Powdered clay in water _____ is, is not a mixture.
2. The clay _____ does, does not dissolve.
3. The clay pieces _____ do, do not settle.
4. Clay in water makes a mixture called a _____ liquid solution, suspension.
5. The parts of a suspension _____ do, do not dissolve.
6. The parts of a suspension _____ do, do not settle out.

WHICH SETTLES FIRST?

TRY THIS!

Place some pebbles, sand, and powdered clay into a jar (Figure C).

Add water nearly to the top.

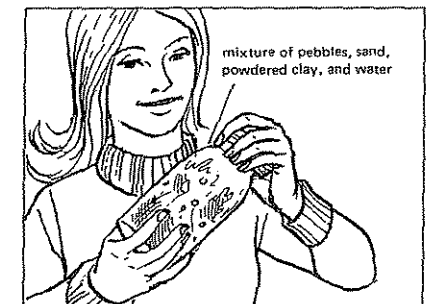
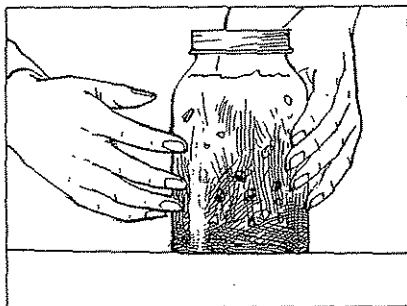


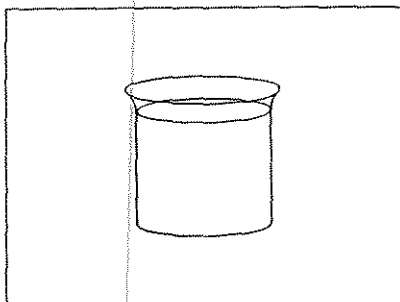
Figure C

Let it stand for five minutes. Observe what happens.



1. Did the pieces settle in layers?

2. Complete Figure E. Show the layers.
Label them.



3. a) Which pieces settled first? _____
 b) They are the _____ pieces.
 largest, smallest
 c) They also are the _____ pieces.
 lightest, heaviest

4. a) Which settled last? _____
 b) They are the _____ .
 largest, smallest
 c) They also are the _____ .
 lightest, heaviest

5. This shows that when a suspension settles, the _____ pieces settle
 heavy, light
 first; the _____ pieces settle last.
 heavy, light

6. Usually, the heavy pieces are _____ ; the light pieces are _____
 small, large
 _____ ,
 small, large

The diagram illustrates the process of sediment transport and deposition at a river mouth. A stream flows from the left, carrying rocks and pebbles. As it enters the ocean, the sediment settles in layers: pebbles near the shore, followed by sand, and finally clay further out. A sailboat is visible in the ocean, and a bird is flying in the sky.

Streams pick up and carry sediment like sand, rocks, clay, and pebbles. Streams deposit this sediment where they empty.

1. Name some kinds of sediment streams carry.

2. The _____ are deposited first because they are the _____
heaviest, lightest
3. The _____ is deposited last because it is the _____
heaviest, lightest
4. The _____ are deposited closest to the shore.
5. The _____ is deposited farthest from shore.
6. List the sediments in the order that they are deposited: _____

Use what you have learned about solutions and suspensions to fill in this chart.

	Solutions	Suspensions
Do the parts dissolve? (yes or no)		
Do the parts settle? (yes or no)		

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | | |
|----------|----------------------------------|------------------------|
| 1. _____ | liquid solutions | a) parts do not settle |
| 2. _____ | suspensions | b) settle last |
| 3. _____ | heavy pieces | c) kinds of mixtures |
| 4. _____ | light pieces | d) parts do settle |
| 5. _____ | liquid solutions and suspensions | e) settle first |

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ Liquid solutions are mixtures.
2. _____ Suspensions are mixtures.
3. _____ Liquid solutions and suspensions are the same kinds of mixtures.
4. _____ The parts of liquid solutions are dissolved.
5. _____ The parts of suspensions are dissolved.
6. _____ Liquid solutions settle out.
7. _____ Suspensions settle out.
8. _____ Suspended pieces always settle at the same time.
9. _____ Suspended pieces settle by weight.
10. _____ In a suspension, heavy pieces settle last.

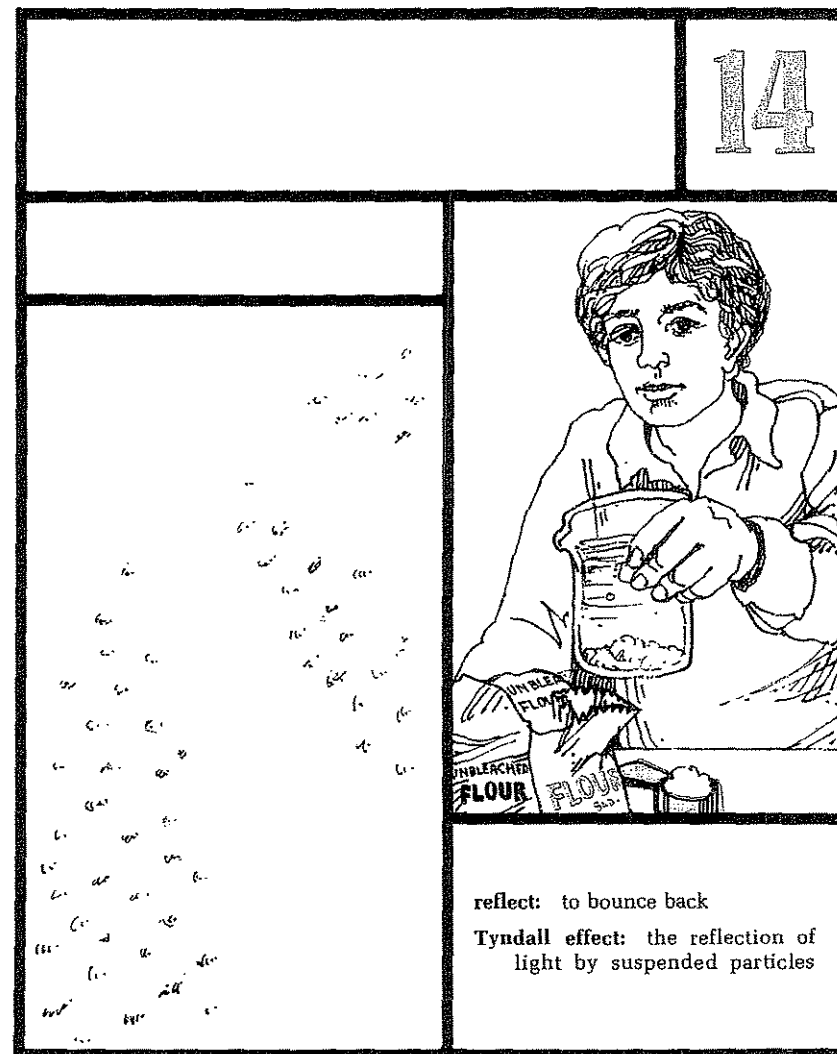
REACHING OUT

Sometimes, streams flood onto land areas. They leave sediment behind.

What is this land good for? _____

WHAT ARE SOME OTHER PROPERTIES OF SUSPENSIONS?

14



reflect: to bounce back

Tyndall effect: the reflection of light by suspended particles

AIM | What are some other 14 | properties of suspensions?

Did you ever add flour to water? What did it look like?

—Was it clear or was it cloudy?

—Did the particles look evenly mixed (homogeneous)?
Or were there more near the bottom of the container?

Flour and water form a suspension. It is *cloudy* and *unevenly mixed*. These are important properties that help us to identify suspensions.

Suspensions have two other important properties.

(1) The parts of a suspension are large. You can see them easily. Even the “small” pieces of flour are large enough to be seen easily.

(2) Suspended particles stop light. Light that hits the particles is reflected. This is why suspensions are cloudy.

Let us now review what you have learned about the properties of suspensions:

- The particles in suspensions do not dissolve.
- The particles in suspensions settle out. They separate into layers by weight.
- Suspensions are cloudy and uneven.
- The solid particles of a suspension are large. You can see them.
- Suspended solids reflect light.

CLEAR AS MUD



Figure A

This boy is holding a mixture of soil and water. He shook it only a few seconds ago.

1. Soil in water is a _____.
solution, suspension
2. Suspensions _____ settle.
do, do not
3. Suspensions are _____.
transparent, cloudy
4. Suspended particles _____ light pass.
let, do not let
5. We _____ see suspended particles.
can, cannot
6. Suspensions _____ mixed evenly.
are, are not
7. The suspended particles _____ the same size.
are, are not

WHAT IS THE TYNDALL EFFECT?

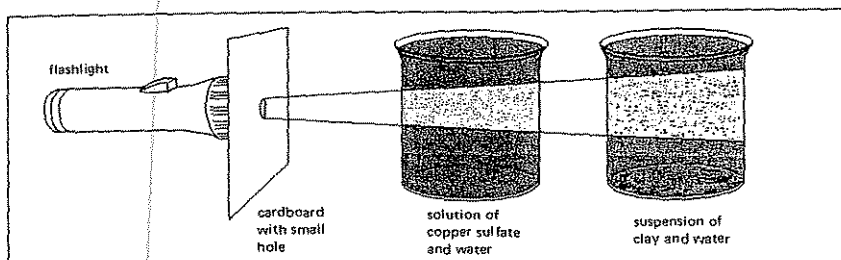


Figure B

TRY THIS!

What To Do

1. Fill a beaker with a solution of copper sulfate and water.
2. Fill another beaker with a suspension of clay and water. Mix it well.
3. Place the beakers on the table next to one another.
4. Let the clay water settle for about two minutes.
5. Shine a flashlight through both beakers as in Figure B.

What You Saw and Learned

1. You _____ see particles in the liquid solution.
can, cannot
2. You _____ see particles in the suspension.
can, cannot

The reflection of light by suspended particles is called the **TYNDALL EFFECT**.

3. You can see suspended particles because they _____ stop light.
do, do not
4. The Tyndall effect _____ help us identify a suspension.
does, does not
5. The Tyndall effect also helps us identify the _____ of suspended particles.
size, kind
6. Which kind of mixture shows the Tyndall effect? _____
solution, suspension
7. Which kind of mixture does not show the Tyndall effect? _____
solution, suspension

WHO WAS THE TYNDALL EFFECT NAMED FOR?

The Tyndall effect was named for John Tyndall. He was a 19th century British scientist.

He studied many things. One was how light passes through the air in different places.



Figure C

	Solutions	Suspensions
1. Do the parts dissolve? (yes, no)		
2. Do the particles settle? (yes, no)		
3. Is the mixture clear or cloudy?		
4. Do the particles reflect light? (yes, no)		
5. Can you see the particles? (yes, no)		
6. Is the mixture homogeneous? (yes, no)		

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Suspensions are mixtures.
2. _____ The particles in suspensions settle out.
3. _____ Suspensions are transparent.
4. _____ Suspensions are cloudy.
5. _____ Homogeneous means evenly mixed.
6. _____ Suspensions are evenly mixed.
7. _____ Suspension particles are the size of molecules.
8. _____ The particles in suspensions stop light.
9. _____ All suspended pieces are the same size.
10. _____ Liquid solutions show the Tyndall effect.

REACHING OUT

Why do "quiet" lakes have clear water?

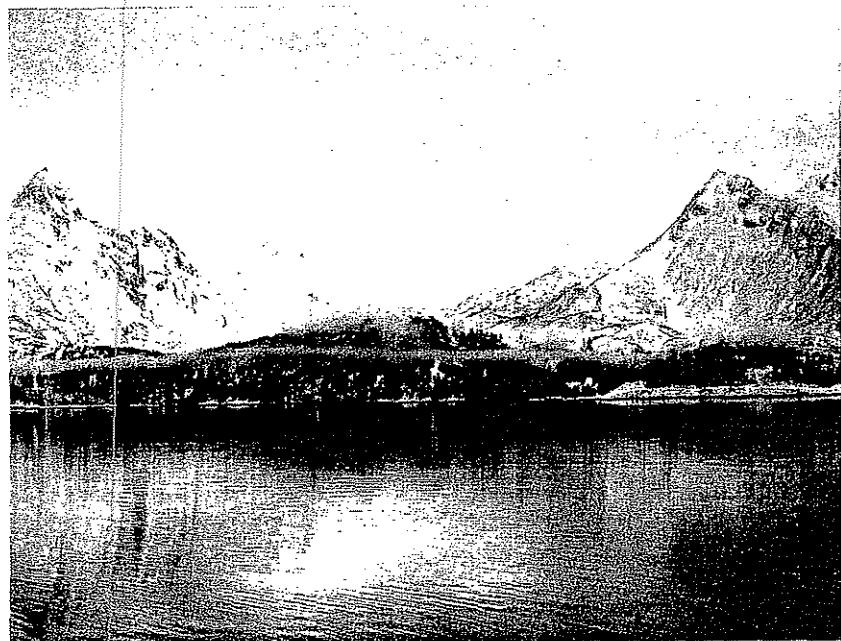
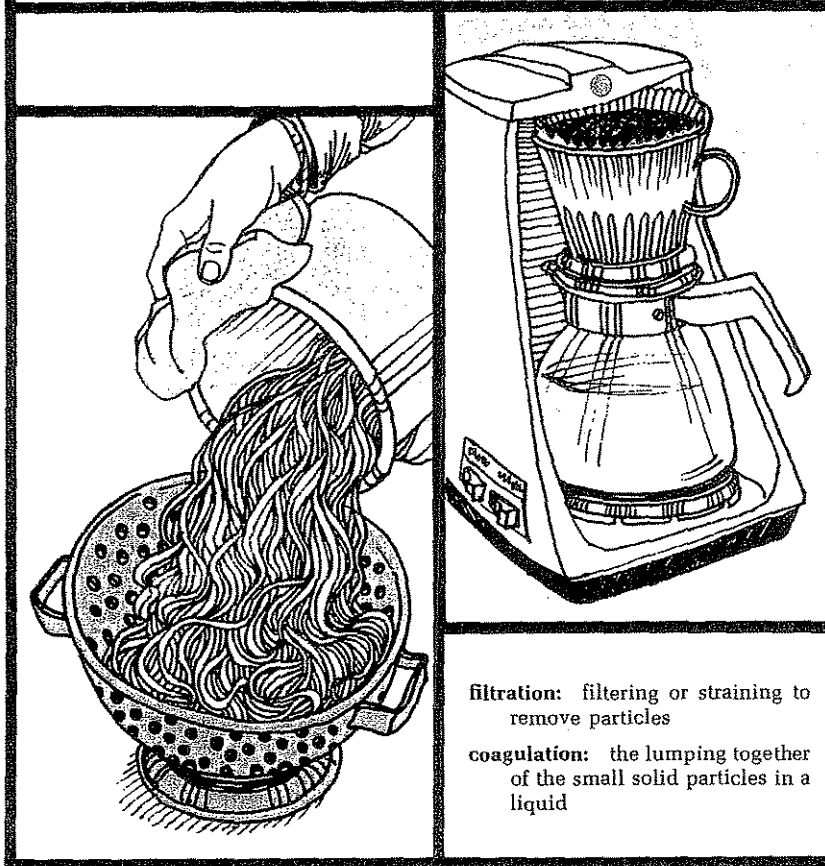


Figure D

HOW CAN WE SEPARATE THE PARTS OF A SUSPENSION?

15



filtration: filtering or straining to remove particles

coagulation: the lumping together of the small solid particles in a liquid

AIM | How can we separate the 15 parts of a suspension?

A cook drains off the cooking water from spaghetti. The wind makes dust fly in the air. But soon it settles.

Spaghetti in water and dust in the air are both suspensions. In both examples, the parts of the suspension separated.

Many kinds of suspensions must be separated. Sometimes, nature separates the parts. Other times we must do it ourselves—or help nature along.

There are four ways to separate suspensions. They are: *filtration* [fil TRAY shun], *sedimentation* [sed uh men TAY shun], *spinning*, and *coagulation* [koe ag yoo LAY shun].

FILTRATION Filtration is the same as straining. A filter has holes. Pieces smaller than the holes pass right through. Larger pieces are trapped behind the filter.

Filters come in many sizes. Some have large holes. Some have small holes. The size of the filter you use depends on the size of the particles you want to separate.

SEDIMENTATION Nature does this job itself. In sedimentation, the suspension just “sits.” Gravity makes the pieces settle to the bottom of their containers.

SPINNING Spinning speeds settling. Spinning builds a strong outward force. The force pushes the pieces to the bottom of the container quickly.

COAGULATION Coagulation also speeds settling. Coagulation uses chemicals. The chemicals make small particles lump together. They become heavy and settle fast.

FILTRATION

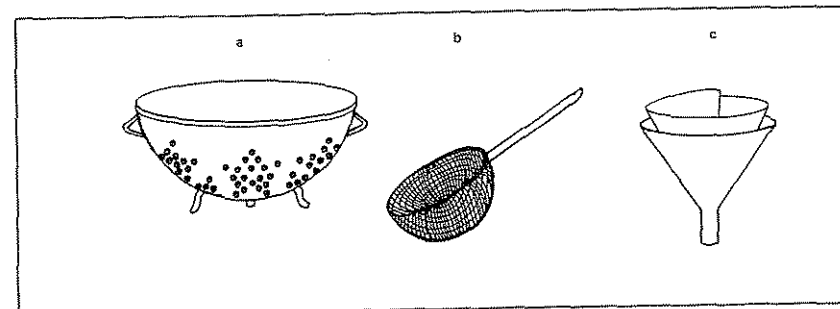


Figure A

1. Which filter separates out the largest pieces? _____
2. Which one separates out the smallest pieces? _____
3. Which filter would you use to strain spaghetti? _____
4. Does filtration use chemicals? _____

SEDIMENTATION

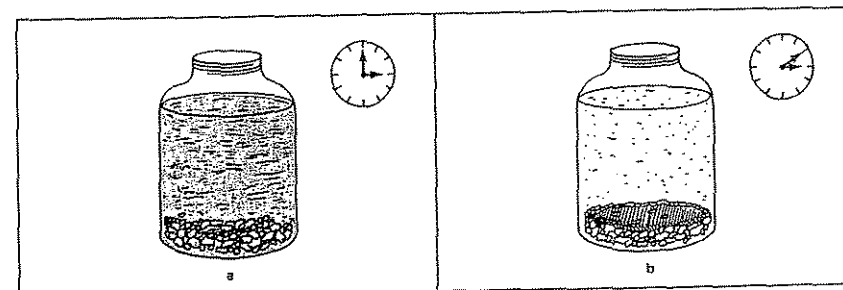


Figure B

1. In sedimentation:
 - a) the heaviest pieces settle _____ first, last
 - b) the lightest particles settle _____ first, last
2. Sedimentation is done by _____ gravity, spinning
3. Does sedimentation use chemicals? _____

SPINNING

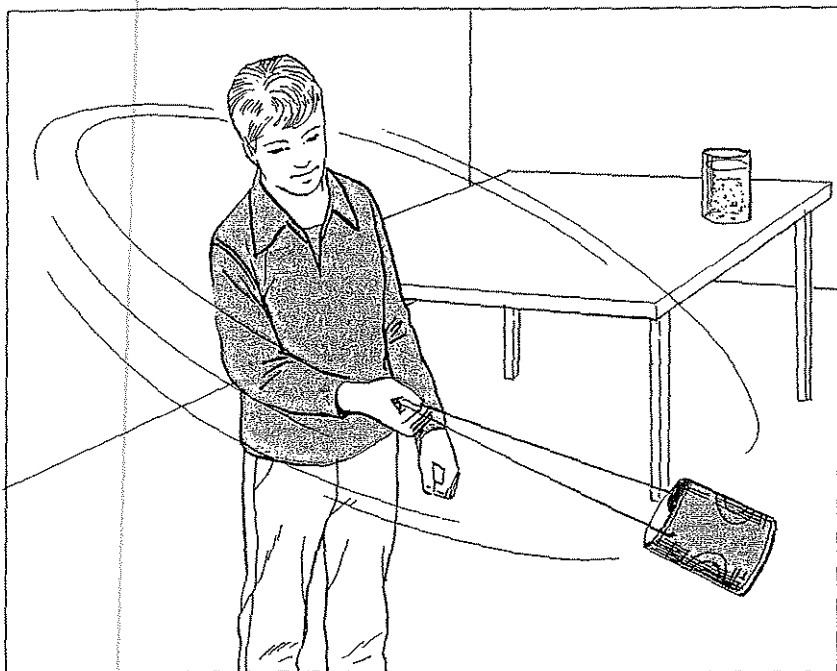


Figure C

There are suspensions of clay and water in the can and the beaker.

1. The clay pieces will settle first in the beaker, can.
2. The pieces in the beaker are settling by spinning, gravity.
3. The pieces in the can are settling by spinning, gravity.
4. Spinning causes an outward, inward force.
5. Spinning speeds, slows settling.
6. Does spinning use chemicals?

COAGULATION

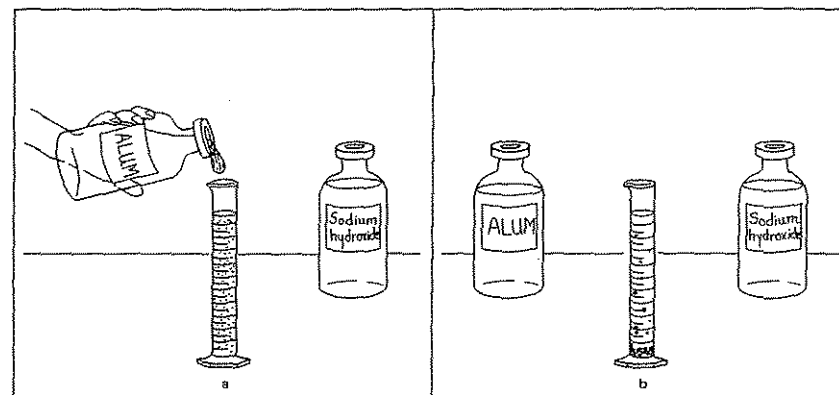


Figure D

1. The suspension in beaker b is settling by coagulation, sedimentation.
2. Coagulation makes small particles lump together, move apart.
3. Coagulated particles become heavier, lighter.
4. Heavy particles settle more slowly, quickly than light ones.
5. Coagulation uses spinning, chemicals and then gravity.

WHEN ARE SUSPENSIONS SEPARATED?

You have learned four ways of removing particles from suspensions. These can be very useful. Here is one example.

Most places get their drinking water from rivers, lakes, or reservoirs. The water has sediment suspended in it. It must be removed so the water can be fit to drink.

Several steps are used to remove the sediment. You will learn about these steps in Aim 18.



Figure E

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

spinning
last
gravity
outward

first
chemicals
sedimentation
speed

coagulation
lump together
filtration
does not

1. The four ways of separating the parts of a suspension are _____, _____, and _____.
2. The method that separates a suspension by trapping particles is _____.
3. In sedimentation, _____ makes the particles settle.
4. Heavy particles settle _____.
5. Lightweight particles settle _____.
6. Spinning and coagulation _____ settling.
7. Spinning builds an _____ force.
8. Spinning _____ use chemicals.
9. Coagulation uses _____ and then gravity to make particles settle.
10. Coagulation makes small pieces _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-------------------------------|--------------------------------|
| 1. _____ gravity | a) causes strong outward force |
| 2. _____ filtration | b) do not dissolve |
| 3. _____ spinning | c) lumps particles together |
| 4. _____ suspension particles | d) pulls things down |
| 5. _____ coagulation | e) traps particles |

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ Suspended particles can be separated.
2. _____ Filtration separates pieces by weight.
3. _____ All filters are the same size.
4. _____ Sedimentation uses gravity.
5. _____ Spinning causes an inward force.
6. _____ Spinning and coagulation speed sedimentation.
7. _____ Filtration uses chemicals.
8. _____ Spinning uses chemicals.
9. _____ Sedimentation uses chemicals.
10. _____ Coagulation uses chemicals.

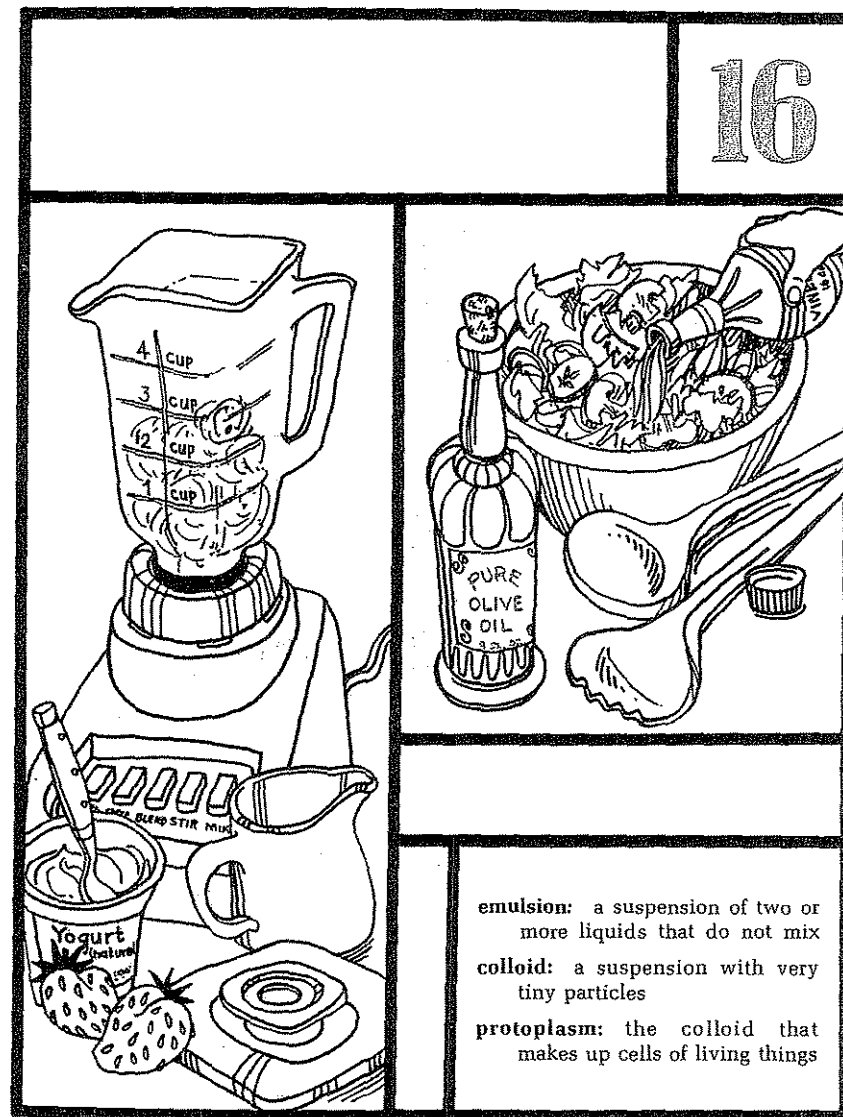
WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. NORFATILIT _____
2. DOTRAWU _____
3. NIPSNGIN _____
4. TAGYVIR _____
5. GALUNOTIAOC _____

REACHING OUT After sediment from a suspension settles, how can you separate it from the liquid?

WHAT ARE EMULSIONS AND COLLOIDS?

16



emulsion: a suspension of two or more liquids that do not mix

colloid: a suspension with very tiny particles

protoplasm: the colloid that makes up cells of living things

AIM | What are emulsions and 16 | colloids?

You have seen muddy water settling out. Muddy water is a suspension of solids in a liquid. But suspensions can also be made up of all liquids.

A suspension made of all liquids is called an emulsion [i MUL shun].

The liquids of an emulsion do not mix evenly. They are immiscible. They separate into layers.

There are many kinds of emulsions. Oil and water form a common emulsion.

A *colloid* [KOLL oid] is still another kind of suspension. The particles suspended in a colloid are very small. They are much smaller than the particles of a regular suspension. But they are larger than molecules.

Colloid particles are very light in weight. They do not settle by themselves. You can make them settle by rapid spinning.

Most colloids look like liquid solutions—transparent and evenly mixed. You cannot see the suspended particles easily. But with a beam of light, the tiny particles show up in the Tyndall test.

Colloids cannot be separated with regular filter paper. The particles are too small.

Glue and gelatin are colloids everyone knows. The most important colloid is *protoplasm* [PRO tuh plazm]. Protoplasm is the living material that makes up cells.

EXPERIMENTING WITH AN EMULSION

TRY THIS!

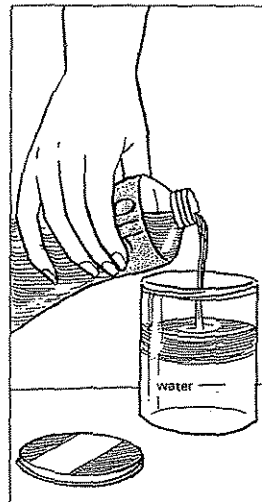


Figure A

Pour some oil and water into a jar.



Figure B

Shake it very well.

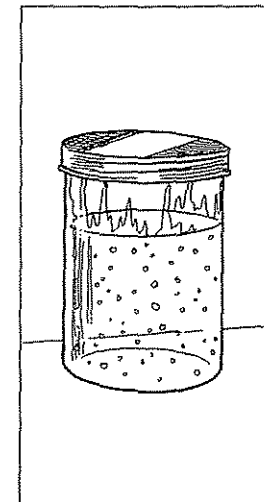
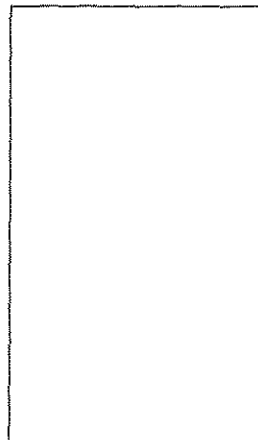


Figure C

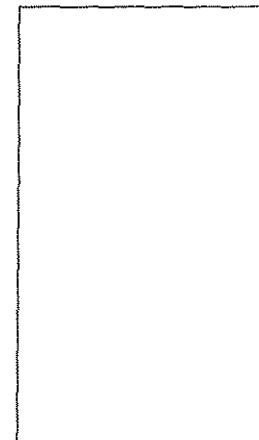
Put the jar on a table. Observe what happens.

Draw pictures of what you see. . .

after 30 seconds



after two minutes



after 10 minutes

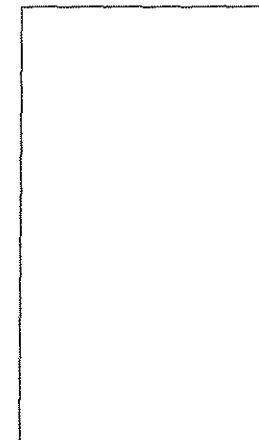


Figure D

1. The oil and water _____ mix evenly.
did, did not
2. The oil and water _____ separate.
did, did not
3. Oil and water _____ miscible.
are, are not
4. Oil and water make a _____.
solution, suspension
5. Oil and water is a special kind of suspension called _____.
a colloid, an emulsion

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ An emulsion is a mixture.
2. _____ An emulsion is a suspension.
3. _____ An emulsion has solid particles.
4. _____ An emulsion has only liquids.
5. _____ The liquids of an emulsion are miscible.
6. _____ Colloid particles are the size of molecules.
7. _____ Colloid particles settle by themselves.
8. _____ Colloids look like solutions.
9. _____ Colloid particles show the Tyndall effect.
10. _____ Colloid particles pass through regular filter paper.

COLLOID OR SOLUTION?

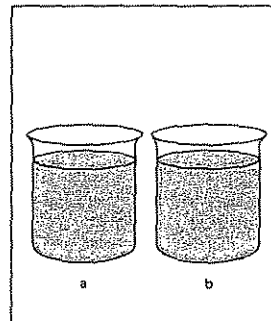


Figure E

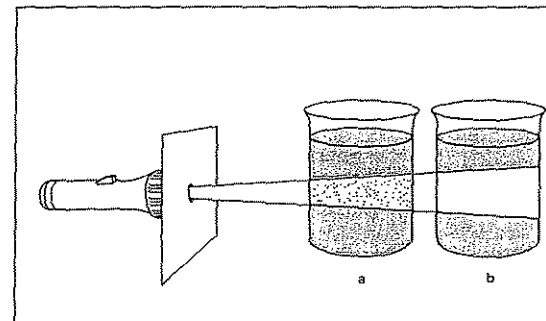


Figure F

One of these mixtures is a liquid solution. The other is a colloid.

They both look the same until we shine a beam of light through them.

1. Beaker _____ shows the Tyndall effect.
a, b
2. Beaker _____ does not show the Tyndall effect.
a, b
3. The liquid solution is in beaker _____.
a, b
4. The colloid is in beaker _____.
a, b
5. _____ particles are the size of molecules.
Colloid, Liquid solution
6. _____ particles are larger than molecules.
Colloid, Liquid solution
7. Which particles will settle by themselves?
a) colloid b) liquid solution c) neither _____
8. Which particles will settle by spinning?
a) colloid b) liquid solution c) neither _____
9. Which particles can be separated with regular filter paper?
a) colloid b) liquid solution c) neither _____
10. A colloid looks like a _____.
liquid solution, suspension

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------------------|-------------------------------------|
| 1. _____ colloid | a) liquids that separate |
| 2. _____ emulsion | b) have parts the size of molecules |
| 3. _____ colloids and emulsions | c) shows Tyndall effect |
| 4. _____ liquid solutions | d) cannot separate colloids |
| 5. _____ regular filter paper | e) suspensions |

THROW ONE OUT In each of the following sets of terms, one of the terms does not belong. Circle that term.

- miscible immiscible emulsion
- oil and water emulsion salt water
- oil and water liquid solution suspension
- only liquids colloid Tyndall effect
- colloid size of molecules glue

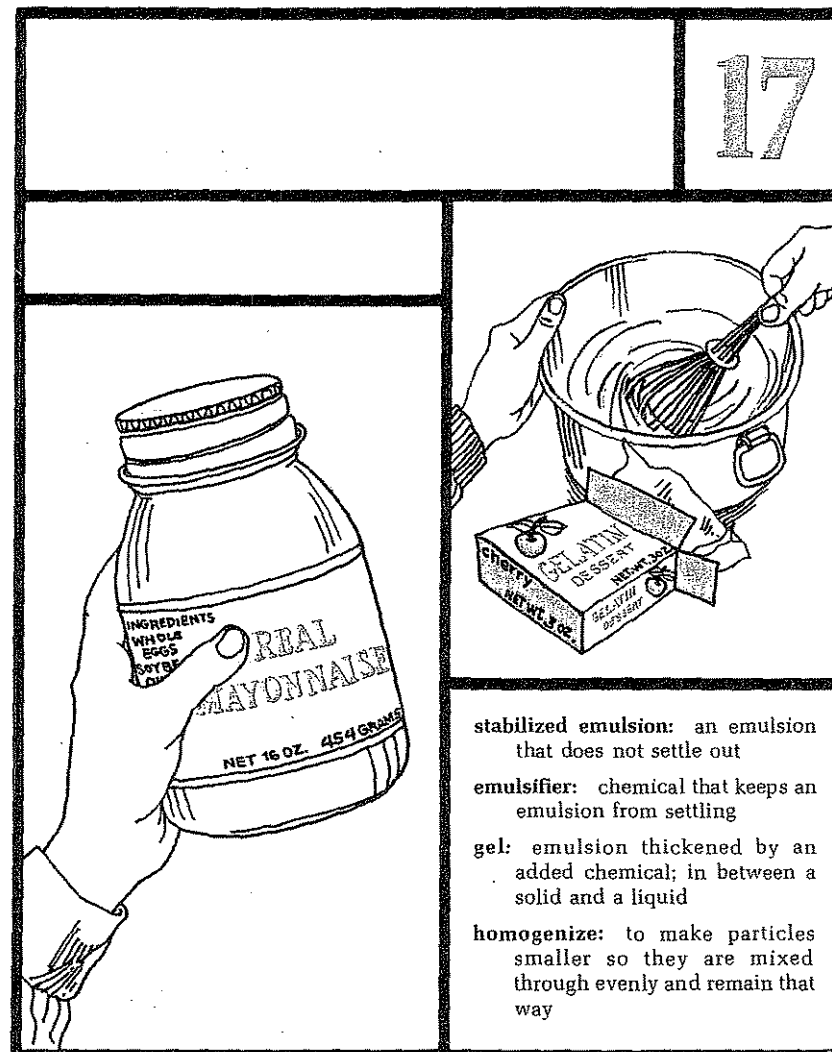
FIND THE HIDDEN WORD **COLLOID** has a total of seven letters. If we take parts of this word or move some of the letters around, they make up other words. Some of the words you have learned in this book. How many of these hidden words in **COLLOID** can you find.

COLLOID

- cover to a jar (3 letters) _____
- having very little heat (4 letters) _____
- not warm, but not too cold (4 letters) _____
- liquid that does not mix with water (3 letters) _____
- sick (3 letters) _____

HOW CAN WE KEEP EMULSIONS FROM SETTLING?

17



The illustration shows a hand holding a jar of 'REAL MAYONNAISE' with ingredients listed as 'WHOLE EGGS' and 'SAFETY'. Another hand is whisking a bowl of emulsion. A box of 'GELATIN DESSERT' is also visible.

stabilized emulsion: an emulsion that does not settle out

emulsifier: chemical that keeps an emulsion from settling

gel: emulsion thickened by an added chemical; in between a solid and a liquid

homogenize: to make particles smaller so they are mixed through evenly and remain that way

AIM | How can we keep emulsions 17 | from settling?

The milk and mayonnaise you buy are emulsions. Yet they do not separate in layers. You don't have to stir or shake them.

This does not seem to agree with what you learned about emulsions. But it really does. Certain things are done to milk and mayonnaise to keep them from settling. They are stabilized [STAY bul ized]. Stabilized emulsions do not settle out.

How do you stabilize an emulsion? There are two ways:

- (a) make the parts very small
- (b) add special chemicals

MAKING THE PARTICLES SMALLER If you shake an emulsion hard, the parts break up. They become smaller. A blender makes the parts even smaller. Small parts take a long time to settle. The smaller the parts, the longer they take to settle.

ADDING SPECIAL CHEMICALS Most emulsions separate even if the particles are very tiny. They may separate slowly—but they still separate.

If we add special chemicals, they do not separate. Chemicals that stop emulsions from separating are called **emulsifiers** [i MUL suh fy erz]. There are several kinds of emulsifiers.

Egg yolk is an emulsifier. It is used in mayonnaise. Mayonnaise is mostly oil and vinegar. Oil and vinegar are immiscible. They do not mix. A chemical in egg yolk keeps the oil and vinegar from separating.

Soaps and detergents are other emulsifiers. They keep the grease that lifts from dirty clothes suspended in the wash water. The grease does not go back into the clothes.

Some chemicals make an emulsion thicken. The emulsion becomes a gel. A gel traps suspended particles. They do not settle out. A gel is in between a solid and a liquid.

OIL AND WATER

TRY THIS!

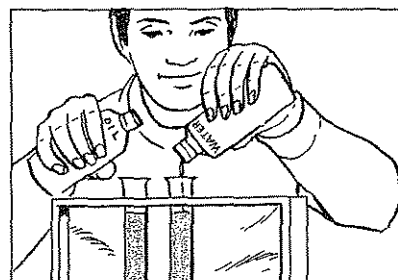


Figure A

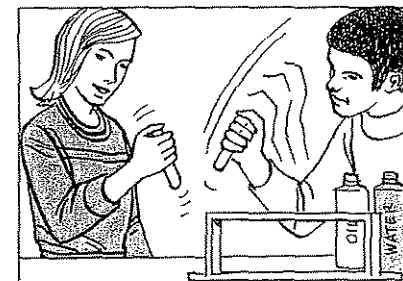


Figure B

What You Need 2 test tubes
oil, water

What To Do

1. Add the same amount of oil and water to each of the two test tubes.
2. Shake both at the same time.
3. Shake one gently.
4. Shake the other one very hard.
5. Put them back in the rack.

What You Saw

1. Draw pictures of how the mixtures look right after shaking.

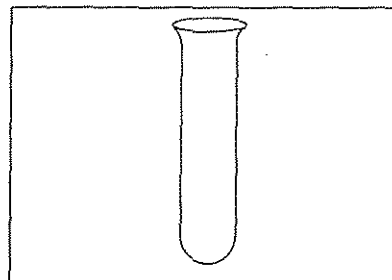


Figure C

after gently shaking

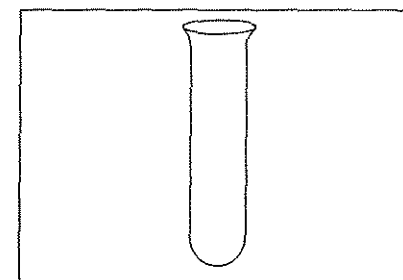


Figure D

after hard shaking

2. Observe the size of the drops of oil. Observe how long each one takes to settle in layers.
3. Fill in this chart. Draw a check (✓) in the box that describes what happened.

	Made Size of Oil Drops Smaller	Left Larger Size Drops of Oil	Separated Slower	Separated Faster
Shaking Gently				
Shaking Hard				

ADDING AN EMULSIFIER

TRY THIS!

What You Need 2 test tubes
oil
water
detergent

What To Do

1. Add equal amounts of oil and water to two test tubes. Label the test tubes a and b.
2. Let the test tubes stand until the parts separate.
3. Add some liquid detergent to test tube b.
4. Cork both tubes and shake hard.
5. Let them stand for a few minutes. See what happens as they stand.

What You Saw and Learn

Look at both test tubes.

1. The parts in test tube _____ separated quickly.
a, b

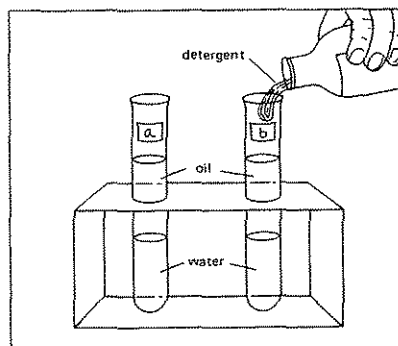


Figure E

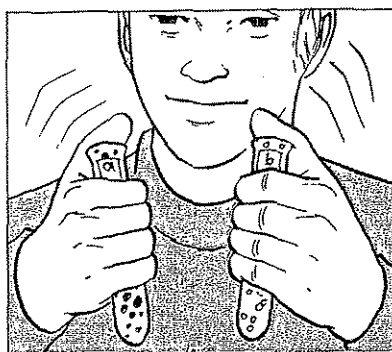


Figure F

2. The parts in test tube _____ did not separate quickly.
a, b
3. Detergent was added to test tube _____.
a, b
4. The detergent _____ the emulsion.
stabilized, separated
5. Detergent is an example of _____.
a colloid, an emulsifier

ABOUT MILK

Milk is a common drink that is a suspension. It is mostly water with proteins, butterfat, sugar, vitamins, and minerals in it. But the parts of milk do not settle out because it has been homogenized.

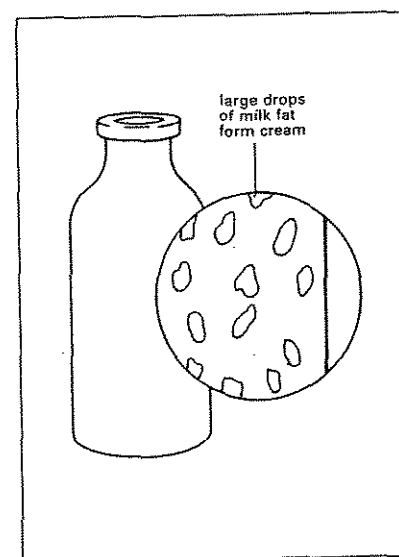


Figure G

Milk that is not homogenized

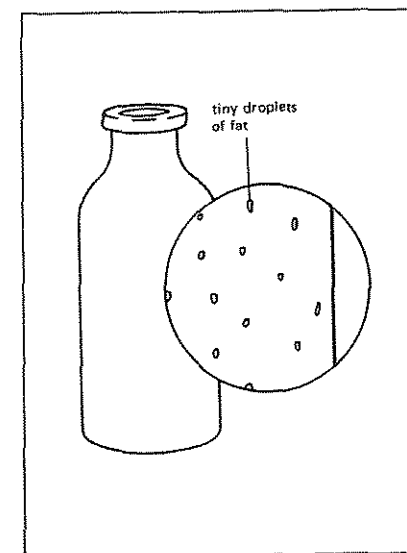


Figure H

Homogenized milk

When milk is homogenized, it is forced through very small holes. This breaks up the drops of fat into tiny droplets. A natural milk protein then keeps the tiny droplets from lumping together again. This is why homogenized milk does not separate in layers.

COMPLETING SENTENCES

Complete the sentences with the choices below.

suspension	emulsion	homogenized
shake	gel	soap
detergents	emulsifiers	adding special chemicals
stabilized	in layers	making the pieces smaller

- Liquids that do not mix together make an _____.
- An emulsion is a kind of _____.
- Emulsions separate _____.
- Any emulsion that does not separate is said to be _____.
- We can stabilize emulsions by _____ or _____.
- The parts of an emulsion become smaller when we _____ it.
- _____ milk does not separate.
- Chemicals that stabilize emulsions are called _____.
- _____ and _____ are examples of emulsifiers.
- A _____ is in between a solid and a liquid.

TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

- _____ Emulsions separate in layers.
- _____ We can keep emulsions from settling.
- _____ Small particles settle fast.
- _____ Hard shaking makes particles larger.
- _____ Milk is homogenized with chemicals.
- _____ Soaps and detergents are chemical emulsifiers.
- _____ Water is a gel.

- _____ A gel is not as soft as a liquid and not as hard as a solid.
- _____ Chemicals are often added to processed foods.
- _____ Gels keep emulsions from settling.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-------------------------------|------------------------------|
| 1. _____ homogenizing | a) stabilizes mayonnaise |
| 2. _____ egg yolk | b) not a solid, not a liquid |
| 3. _____ soaps and detergents | c) kind of suspension |
| 4. _____ emulsion | d) stabilizes milk |
| 5. _____ gel | e) chemical emulsifiers |

WORD SEARCH

The words in this list are hidden in the groups of letters. Try to find each word. Draw a line around each word. The spelling may go in any direction: up-and-down, across, or diagonally.

EMULSIFY
EGG YOLK
STABILIZE
MILK
EMULSION
CLOUDY
TYNDALL
CLEAR
COLLOID

L	E	S	L	I	E	D	O	W	A	R
D	M	I	L	L	I	E	I	Z	A	E
I	E	G	G	Y	O	L	K	E	L	Z
V	L	M	A	N	A	T	L	M	A	I
A	Y	D	U	O	L	C	F	E	K	L
D	E	M	U	L	S	I	O	N	D	I
F	T	L	I	M	S	N	Y	T	G	B
G	A	R	Y	K	L	I	M	O	U	A
D	I	O	L	L	O	C	F	L	D	T
C	L	L	A	D	N	Y	T	Y	T	S

REACHING OUT

Many of the foods we eat are processed. Things are done to the food. One process kills harmful germs.

1. You have learned that milk is homogenized. What else is done to store-bought milk that makes it different from "raw" milk?

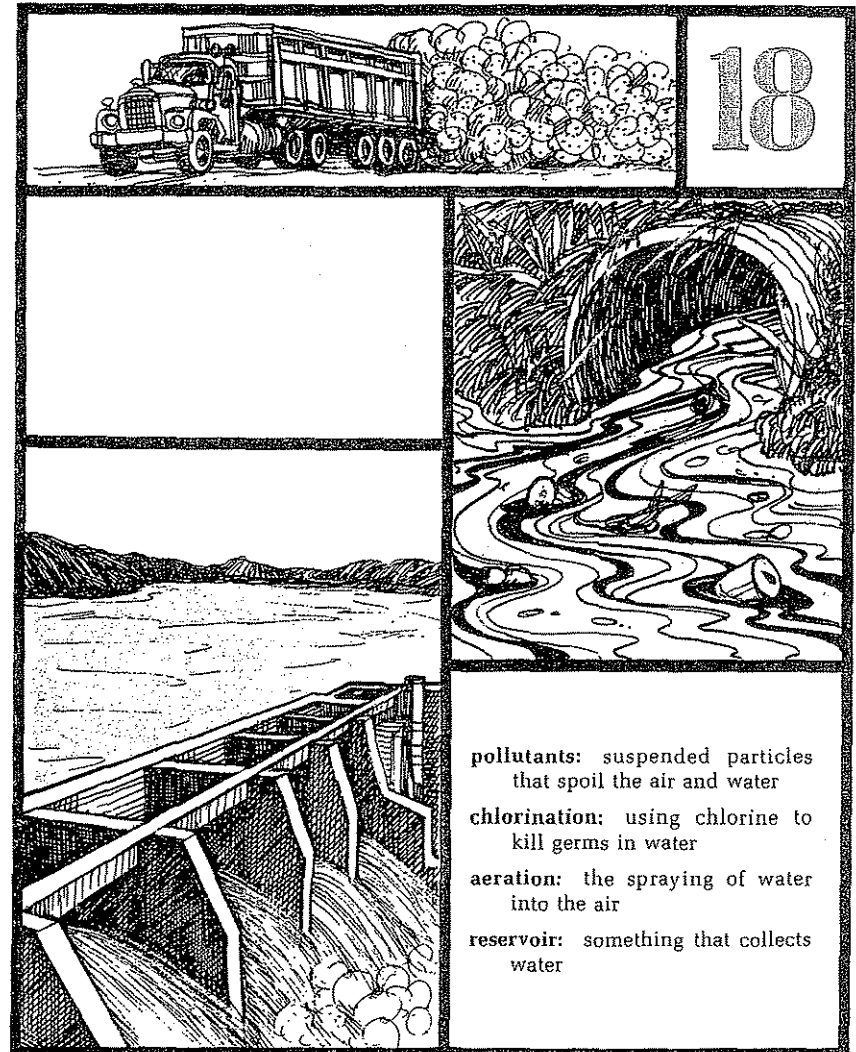
Many chemicals are added to our food. These are *food additives*. Emulsifiers and stabilizers are food additives. Other additives change the color or flavor of food. Some keep the food fresher longer. Eating large amounts of these additives may be harmful to your health.

2. Look at the foods in the picture. Which of these foods do you think have food additives? _____
3. Bring in some food labels from home. READ THE LABELS. List the food additives you find. _____



Figure L

WHAT IS POLLUTION AND HOW CAN WE PURIFY WATER?



AIM | What is pollution and how 18 | can we purify water?

Smoke particles in the air, cloudy swirls of chemicals in a river—these are examples of suspensions. But these are special cases. The suspended particles are pollutants [puh LOO tents].

Where do these pollutants come from?

Air pollution comes from many sources. Automobile exhaust is a common one. All burning gives off gas wastes. Some burning gives off solid wastes too—like ash and soot. These wastes pollute the air. A great deal of air pollution also comes from factories.

Pollution harms our waters as well as our air. Many kinds of wastes are dumped into our oceans, rivers, lakes, and streams. They include raw sewage, garbage, detergents, and factory chemicals. Detergents kill fish and plant life. Factory chemicals kill many fish when waste is dumped in water.

People have begun to do something about pollution. Car engines and fuels have had to be changed to obey new pollution laws. Factories must now control the smoke that leaves their stacks.

Cities have had to find new ways to deal with their garbage and sewage. They can no longer just dump it into rivers and oceans.

When you turn on the tap, you expect good, clean water to drink. In farm areas, people may have their own water sources. But near cities, giant water purification plants must purify water for millions of people.

AIR POLLUTION

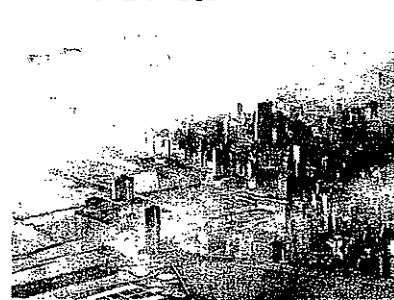


Figure A

Air pollution is unhealthy. It is especially harmful to people with allergies or breathing problems.



Figure B

Smog is a special form of pollution. It is a mixture of smoke, fog, and chemicals. Smog "hugs" the ground. It burns the eyes and makes it hard to breathe.



Figure C

Radioactive fallout is an extra dangerous form of pollution. It may come from atomic test explosions or atomic plants. Radioactivity pollutes every part of our environment—the air, the land, and the waters. It even finds its way into our foods.



Figure D

Water pollution "kills" lakes. No fish or plants can live in "dead" lakes.

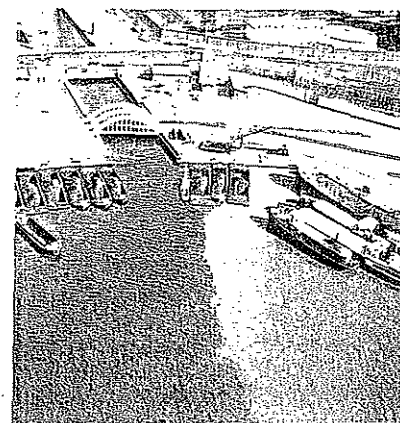


Figure E

Oil dumping and oil spills pollute large areas of water and shore.

FIND THE AIR POLLUTERS



Figure F

Figure F shows some sources of air pollution. They are named below. Match the letter with the polluter.

- | | |
|-------------------------|----------------------------|
| 1. burning leaves _____ | 4. cigarette smoking _____ |
| 2. home chimneys _____ | 5. burning garbage _____ |
| 3. automobiles _____ | 6. factories _____ |

FIND THE WATER POLLUTERS

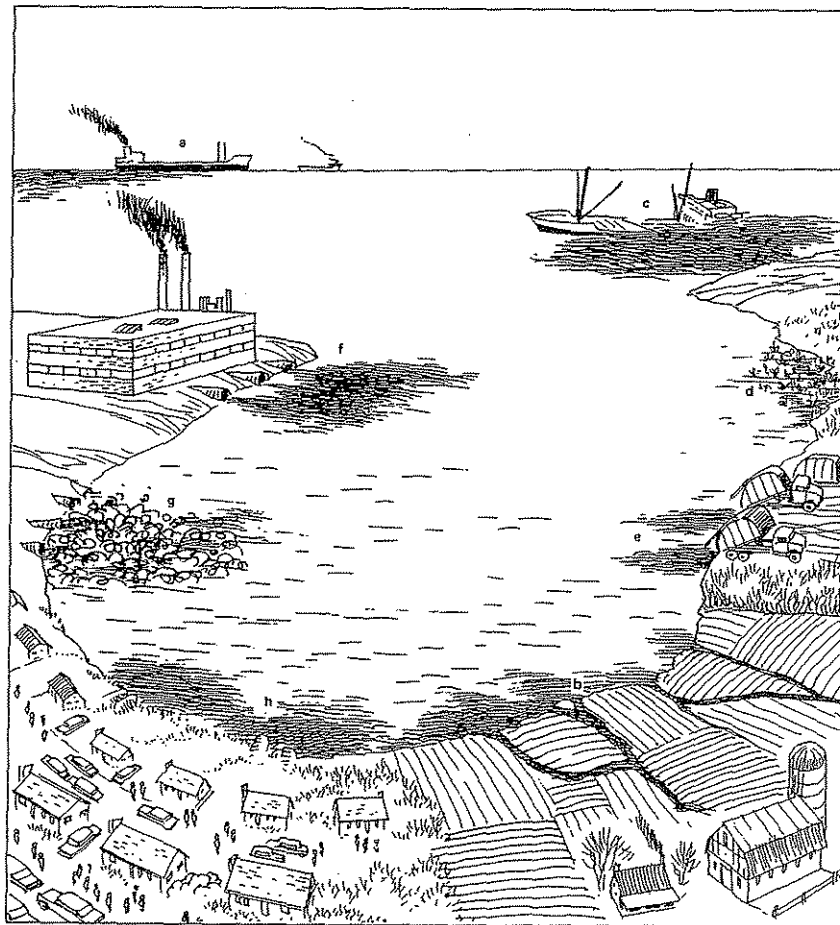


Figure G

Figure G shows some sources of water pollution. They are named below. Match the letter with the polluter.

- | | |
|---------------------------------|--------------------------------|
| 1. homes _____ | 5. decaying water plants _____ |
| 2. factories _____ | 6. ships _____ |
| 3. detergents _____ | 7. oil spills _____ |
| 4. fertilizers from farms _____ | 8. garbage dumping _____ |

HOW WATER IS PURIFIED

The water most people use in their homes has been treated in a water purification plant. Follow the different steps the water goes through to make it clean.

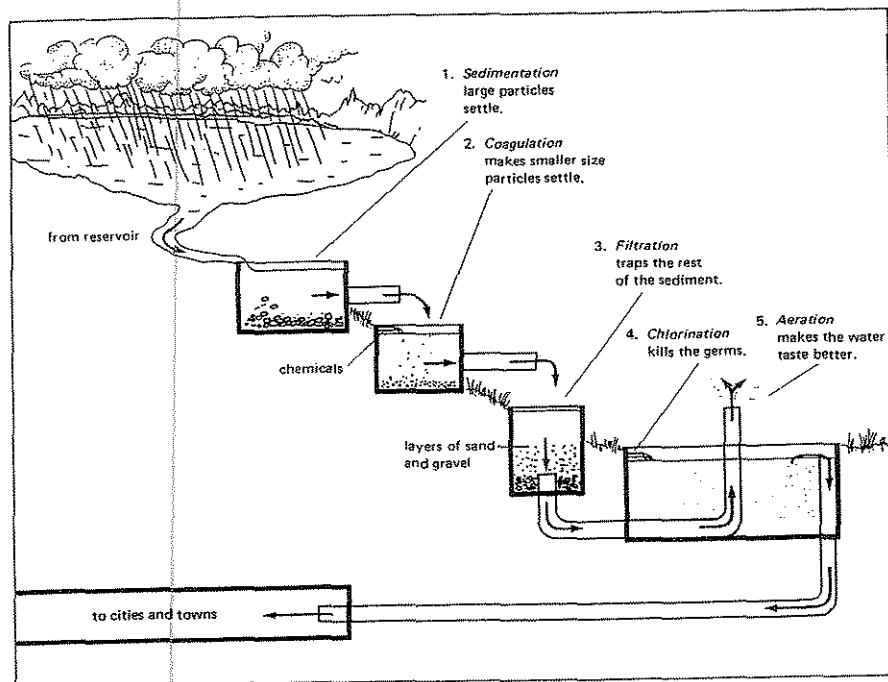


Figure H

Rain water is usually pure and safe. When rain water hits the ground, it picks up many kinds of sediment. Sometimes it even picks up dangerous germs.

Purification [pure uh fih KAY shun] gets rid of the sediment and germs.

There are five steps in purification. They are: sedimentation, coagulation, filtration, chlorination [klor i NAY shun] and aeration [air AY shun].

1. In sedimentation, heavy particles settle by themselves.
2. Small particles are still in the water after sedimentation. They are made to settle by coagulation. Chemicals are added to the water. The chemicals make the particles lump together. They become heavy and settle.
3. Filtration strains out any particles that are left after sedimentation and coagulation.

4. Chlorine [KLOR een] is a chemical that kills germs. Chlorination kills germs in water. (Not every purification plant does this.)
5. In aeration, the water is sprayed into the air. The air mixes in with the water. Aeration makes the water taste better.

Next time you drink water, think about what happened to it before it reached your tap.

FILTER WATER YOURSELF

See for yourself how filtration takes out particles from water.

What You Need

beaker of muddy water
funnel
ring stand
empty beaker
gravel
fine pebbles
sand

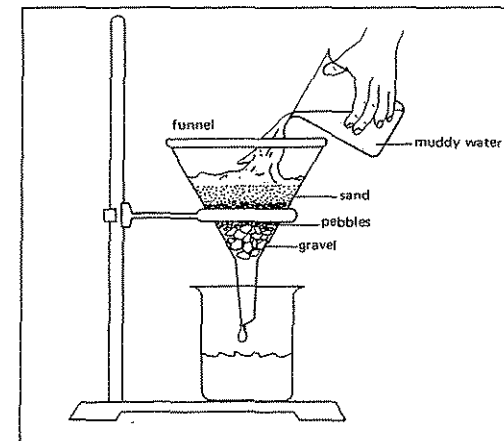


Figure I

What To Do

Set up the funnel, ring stand, and empty beaker as shown in Figure I. Pass some dirty water through the layers of sand and gravel.

What You Saw

What does the water look like after it passes through the sand, pebbles, and gravel?

FILL IN THE BLANKS Write the correct term in each blank to answer the question or complete the sentence.

1. Making water clean and safe to drink is called _____.
2. List the steps of purification in the order that they take place: _____,
_____, _____, _____.
3. Which step clears the heaviest particles? _____
4. Which step traps the last bits of dirt? _____
5. Which step uses chemicals to help the pieces settle? _____
6. Which step kills germs? _____
7. Which step makes the water taste better? _____
8. What is mixed into the water to make it taste better? _____

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Pollution has many sources.
2. _____ Water purification gets rid of sediment.
3. _____ Reservoirs hold water for drinking.
4. _____ Sediments can wash into reservoirs.
5. _____ Nothing has been done to stop pollution.
6. _____ Chlorination traps dirt.
7. _____ Aeration takes the air out of water.
8. _____ Coagulation uses chemicals.
9. _____ Gravity helps sedimentation.
10. _____ Only people in cities should worry about pollution.

WHAT ARE ACIDS?

19

acid: sour chemical that turns blue litmus paper red

indicator: chemical that changes color when certain substances are added

chemical formula: a shorthand way of writing the name of a compound; for example, H_2O stands for water

hydrogen gas: a gas that is given off when acids wear away metal

AIM | What are acids?

19 |

You are given a liquid. You don't know what it is. But you are asked to identify it. You are told only that it is not harmful. What would you do? You would look, touch, and smell it. You would let your senses help you find an answer.

You might even taste the liquid and . . . it's lemon juice!! Your face wrinkles at its sour taste.

Scientists also use their senses to identify chemicals. They sometimes test by tasting and feeling. But these tests can be dangerous. They are used only when it is known for sure that the substance being tested is not harmful.

The sour taste of the lemon juice tells us that it is an ACID. Acids are special kinds of chemicals. They are common in everyday life. Some are helpful, some are harmful. There are some that are weak. Others are strong. Many acids are dangerous to touch or taste.

Besides the sour taste that acids have, there are other tests for identifying them. Certain chemicals change color when acids are added.

Chemicals that change color are called indicators [IN di KAY ters].

An example of an indicator is litmus [LIT muss] paper. Litmus paper comes in two colors, red and blue.

Acids turn blue litmus paper red. Acids do not change the color of red litmus paper.

Another test used for acids is the metal test. Acids wear away metals. Hydrogen gas is given off while the metal is changing.

Only acids in a liquid form show these properties. Dry acids do not.

PROPERTIES OF ACIDS



Figure A

Acids taste sour.

Name another fruit that contains acid . _____

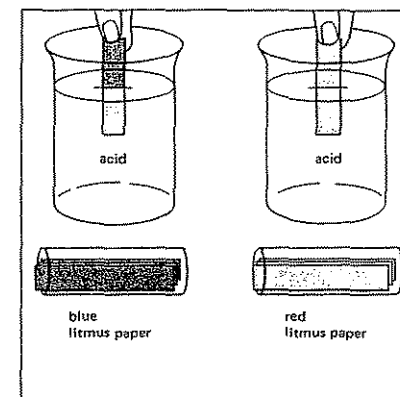


Figure B

Acids turn blue litmus paper red.

Does the red litmus paper change color with acids? _____

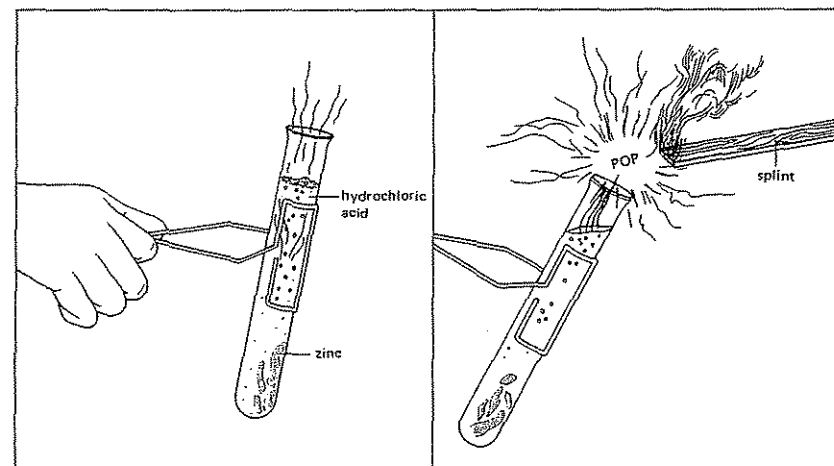


Figure C

Acids wear away metals. Hydrogen gas is given off as it wears away.

If you place a burning splint near the neck of the test tube you hear a tiny "pop." This shows that the gas is hydrogen.

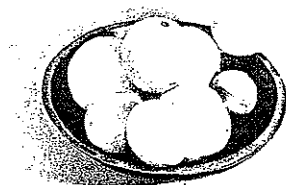


Figure E

Citrus fruits have an acid called citric acid.



Figure D

Aspirin is (try to pronounce it!) acetylsalicylic acid.



Figure F

Milk has lactic acid.



Figure G

Vinegar is acetic acid.

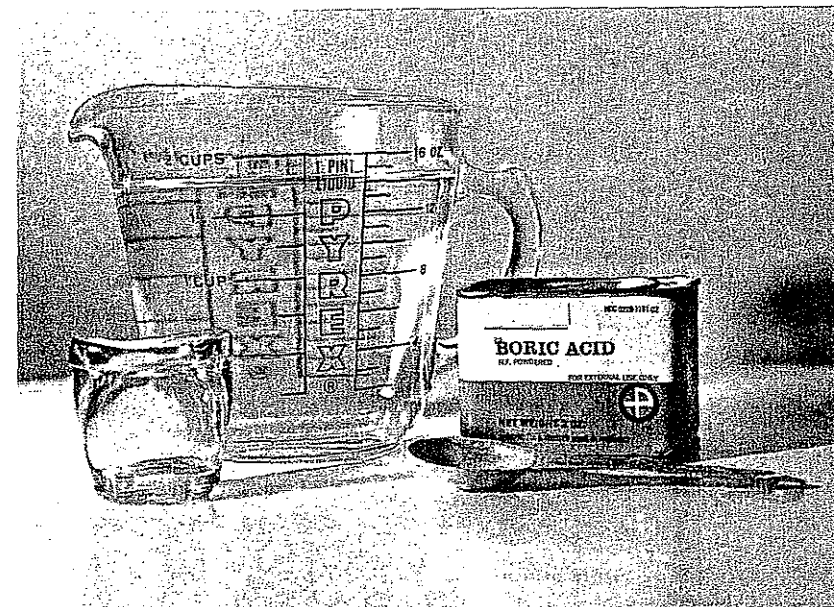


Figure H

Your doctor may tell you to use a boric acid solution as an eyewash or to treat a burn.



Figure I

Sulfuric acid is used in car batteries.



Figure J

The hydrochloric acid made by your stomach helps you digest protein.

SOME COMMON ACIDS

The chart lists some common acids and their chemical formulas. It shows you what all acids have in common.

The hydrogen that "pops" in Figure C comes from the acid.

Acid Name	Chemical Formula	All acids have a special form of the element hydrogen (H^+).
Carbonic acid	H_2CO_3	
Hydrochloric acid	HCl	
Sulfuric acid	H_2SO_4	
Nitric acid	HNO_3	
Acetic acid	$HC_2H_3O_2$	
Boric acid	H_3BO_3	

COMPLETING SENTENCES

Complete the sentences with the choices below.

blue
liquid
hydrogen gas

vinegar
red
taste

hydrochloric acid
litmus paper

- You should _____ only those substances that you know are not harmful.
- _____ is a kind of indicator.
- Acids turn _____ litmus paper red.
- _____ litmus paper does not change color in acids.
- When acids wear away metals, _____ is given off.
- Acetic acid is found in household _____.
- Your stomach makes _____.
- Dry acids do not show the same properties as those in _____ form.

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

- _____ Acids taste sweet.
- _____ You can drink lactic acid.
- _____ Litmus paper is an indicator.
- _____ Litmus paper indicates if a liquid is an acid.
- _____ Acids turn red litmus paper blue.
- _____ Your body makes hydrochloric acid.
- _____ Acids have a special form of hydrogen.
- _____ Acids wear away metals.
- _____ Oxygen is given off when acids wear down metals.
- _____ Only dry acids can be tested with litmus paper.

FILL IN THIS CHART

	Taste	Litmus Paper Test	Metal Test	Contain Which Element In Special Form?
Acids		Turn blue litmus paper _____	_____ away metals	

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

- CADI
- TRINOCDA
- SSTTE
- SITLUM
- RUSO

REACHING OUT

Sometimes when rain falls it mixes with pollution particles in the air. An acid is formed.

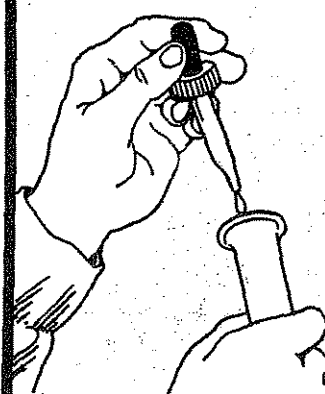
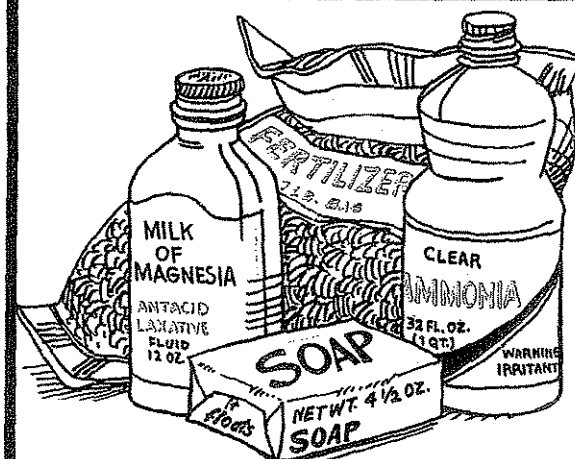
Why might this be harmful? _____



Figure J

WHAT ARE BASES?

20



base: bitter chemical that turns red litmus paper blue

phenolphthalein: an indicator that turns a deep pink color when a base is added

AIM | What are bases?

20

The batter runs to first. There are players on second and third. Bases are loaded! These are bases you know of. Now let us learn about some other kinds of bases.

Bases are a group of chemicals that have certain properties. Their properties are different from the properties of acids. Often they act opposite to the ways that acids act.

Let us see how bases act with the tests that we use to identify chemicals.

Bases that are not harmful have a *bitter taste*.

If you touch a harmless base it will *feel slippery*. (Acids do not have any special feel.)

Bases act the opposite way from acids with indicators.

Bases turn red litmus paper blue. They do not change blue litmus paper.

There is another indicator that helps us to identify bases. It is called *phenolphthalein* [fee nole THAL in]. This solution is clear in acids. But phenolphthalein turns deep pink in bases.

Unlike acids, bases do not wear away metals.

Only liquid bases show these properties. Dry bases do not.

Bases may be of different strengths. Some are very weak. Some are very strong. Some bases are dangerous to touch or taste.

PROPERTIES OF BASES

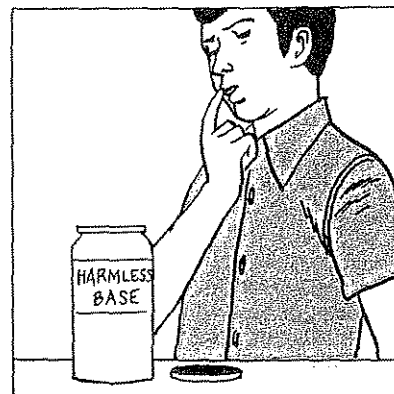


Figure A

Bases taste bitter. How do acids taste? _____



Figure B

Bases feel slippery or soapy. Would you do this test on all bases? _____

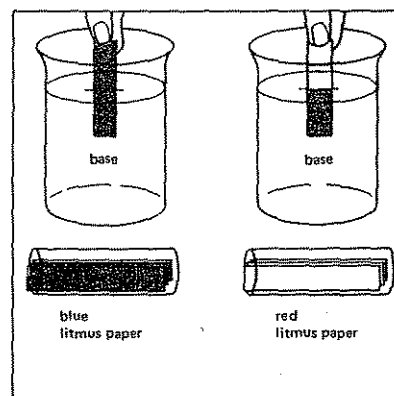


Figure C

Bases turn red litmus paper blue. Blue litmus paper does not change color.

What happens to blue litmus paper in acids? _____

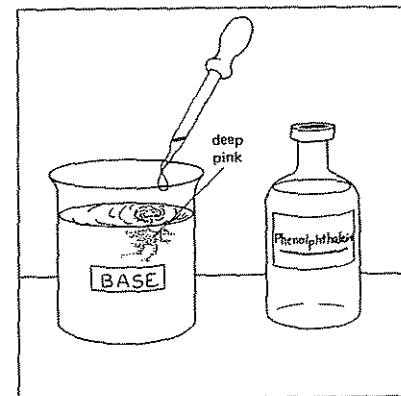


Figure D

Phenolphthalein turns deep pink in bases.

What happens to phenolphthalein in acids? _____

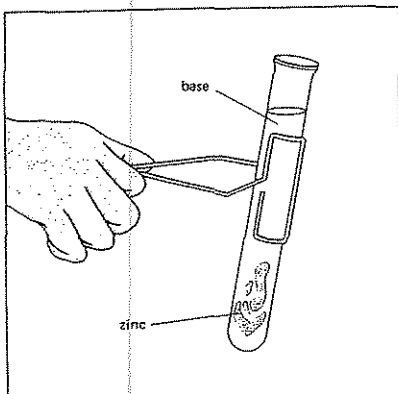


Figure E

Bases do not wear away metals.
No hydrogen gas is given off.

Do acids wear away metals?

SOME COMMON BASES

The chart lists some common bases and their chemical formulas. It shows you what all bases have in common.

Common Name	Chemical Name	Formula	All bases contain special groups of oxygen and hydrogen atoms called hydroxides. (OH ⁻)
Ammonia water	ammonium hydroxide	NH ₄ OH	
Limewater	calcium hydroxide	Ca(OH) ₂	
Lye	sodium hydroxide	NaOH	
Milk of Magnesia	magnesium hydroxide	Mg(OH) ₂	

FILL IN THE CHART Use what you have learned about acids and bases to fill in this chart.

	Taste	Litmus Paper Test	Phenolphthalein Test	Metal Test	Contain H ⁺ or OH ⁻ (Which One?)
Acids					
Bases					

BASES IN EVERYDAY LIFE



Figure F

Ammonia water does many cleaning jobs.

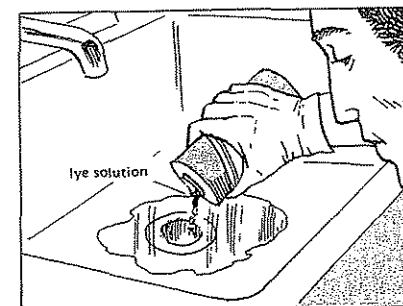


Figure G

Lye is used to open clogged drains.

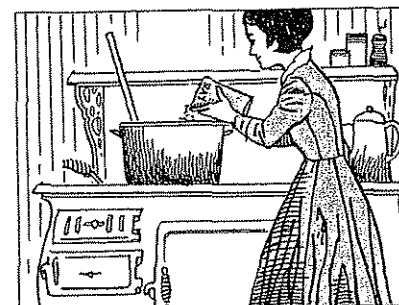


Figure H

Lye is also used to make soap.



Figure I

Your doctor may tell you to take milk of magnesia to help empty your digestive tract.

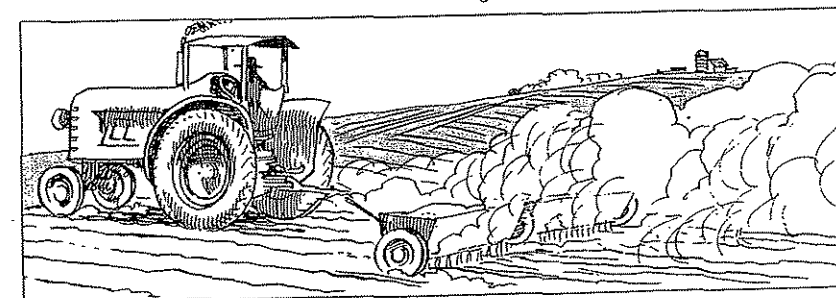


Figure J

Ammonium hydroxide is important in making fertilizers.

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Bases taste sour.
2. _____ Bases feel slippery.
3. _____ Bases turn blue litmus paper red.
4. _____ Bases turn red litmus paper blue.
5. _____ Phenolphthalein turns deep pink in bases.
6. _____ Bases wear away metals.
7. _____ Only liquid bases can be tested with litmus paper.
8. _____ Acids contain the OH^- groups.
9. _____ Acids contain the H^+ groups.
10. _____ All bases are strong.

**FIND THE
HIDDEN
WORDS**

SLIPPERY has a total of eight letters. If we take parts of this word or move some of the letters around, they make up other words. Some of the words you have learned in this book. How many of these hidden words in **SLIPPERY** can you find?

SLIPPERY

1. part of your face right under your nose (3 letters) _____
2. a common base used in soap (3 letters) _____
3. what the temperatures do when something is heated (4 letters) _____
4. an answer (5 letters) _____

WHAT HAPPENS WHEN WE MIX AN ACID WITH A BASE?

21



neutral: not an acid and not a base

chemical reaction: a chemical change in the way atoms link up

neutralization: the forming of a salt and water from the combining of the right amounts of an acid and a base

AIM | What happens when we mix 21 | an acid with a base?

In a courtroom, a judge is not supposed to take sides. The judge is there to make sure that everything is fair for both sides. An umpire does the same thing in a baseball game. We say that people like judges and umpires are neutral.

In chemistry, a liquid is neutral if it is not an acid nor a base.

Take water, for example. Water is neutral. It is not an acid. It is not a base.

Acids and bases have definite properties. In many ways they are opposite. What happens if you mix an acid with a base?

When you mix an acid with a base, a *chemical reaction* takes place. The atoms from the acid and the base change the way they are linked up. New products are formed. These new products have their own properties. The properties are different from the properties of either acids or bases.

What do you get?

When you mix the right amounts of an acid and a base, you get a salt and water. The salt is dissolved in the water. It forms a salt solution. A salt solution is not an acid; it is not a base. It is *neutral*.

ACID + BASE $\xrightarrow{\text{makes}}$ A SALT AND WATER

The link-up of an acid and a base to form a salt and water is called *neutralization* [new truh li ZAY shun].

There are many kinds of salts. The salt you sprinkle on your food is just one kind of salt. Its formula is NaCl. Different salts have different formulas.

SEE WHAT HAPPENS WHEN YOU MIX AN ACID AND A BASE

What You Need dilute hydrochloric acid (HCl)
dilute sodium hydroxide (NaOH)
(The acid and base must be the same strength.)
small test tube
2 droppers
glass stirring rod
phenolphthalein
red and blue litmus paper
test tube holder

Caution—Handle these chemicals carefully!

What To Do

1. Place 20 drops of sodium hydroxide into the test tube.
2. Add one drop of phenolphthalein.

The phenolphthalein turns deep pink.

This shows that sodium hydroxide is _____ an acid, a base, neutral

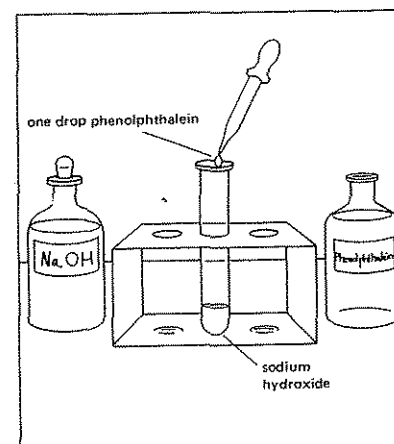


Figure A

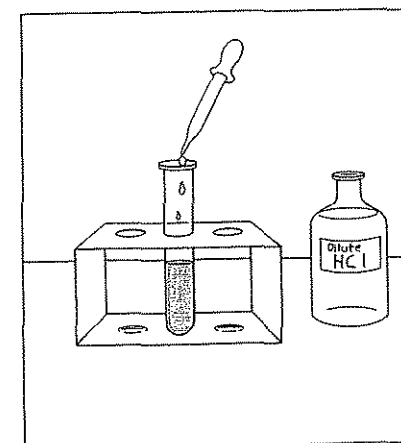


Figure B

3. Add 15 drops hydrochloric acid to the test tube—one drop at a time. (Use a clean dropper.)

The solution stays pink. (Figure B)

This shows that the mixture _____ is neutral, is an acid, is still a base

4. Add more hydrochloric acid . . . one drop at a time. Stir after each drop. Stop when the pink disappears.

The loss of the pink color shows that the mixture is an acid, no longer a base.

5. Test the solution in the test tube with blue litmus paper. (Figure C)

The blue litmus paper stays blue.

This shows that the mixture is not an acid, a base.

6. Test the solution in the test tube with red litmus paper. (Figure D)

The red litmus paper stays red.

This shows that the mixture is not an acid, a base.

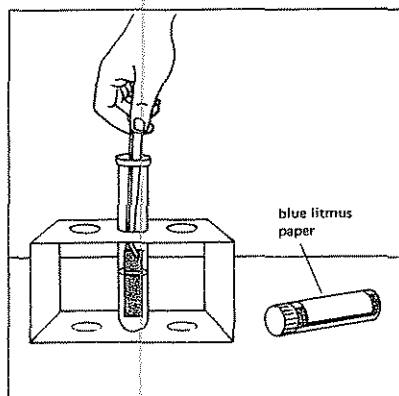


Figure C

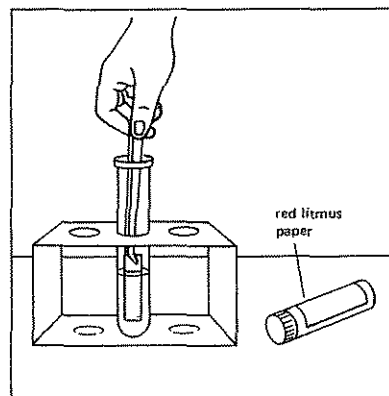
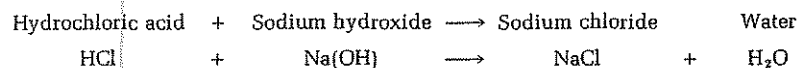
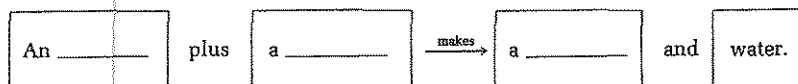


Figure D

7. The mixture is, is not neutral.

8. Fill in the boxes to show what happened.



9. NaCl in H₂O is an acid, a base, salt water.

COMPLETING SENTENCES

Complete the sentences with the choices below. Four of these may be used twice.

water	a base	table
neutralization	many kinds	neutral
litmus paper	reaction	phenolphthalein
an acid	a salt	

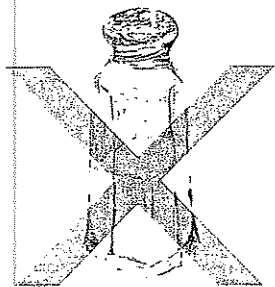
- There are many acids and bases. Lemon juice is an example of an acid.
Lye is an example of a base.
- Any substance that is not an acid nor a base is said to be neutral.
- An example of a neutral liquid is water.
- The mixing of an acid and a base causes a chemical reaction.
- If we mix the right amounts of an acid and a base, we get a salt and water.
- The chemical reaction between an acid and a base to produce a salt and water is called neutralization.
- There are many kinds of salts.
- The most common salt is sodium chloride salt.
- Salt water does not change the color of litmus paper or phenolphthalein.
- Salt water is neither an acid nor a base. Salt water is neutral.

TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

- An acid is neutral.
- A base is neutral.
- Water is neutral.
- There is only one formula for water.
- There is only one kind of salt.
- Salt water is neutral.
- If you mix an acid with a base, you get only water.
- Blue litmus paper changes to red in salt water.
- Red litmus paper stays red in salt water.
- Phenolphthalein turns pink in salt water.

KEEPING UP WITH SCIENCE



'TIS
NOT
THE
SEASONING
TO BE JOLLY!

"Please pass the salt." This is perhaps the most common request at the dining table—except for, "Can I have some more...?"

Sodium chloride, common table salt, is the most widely used seasoning. It has been for thousands of years. In the days before refrigeration, foods spoiled quickly and soon tasted rotten. Salt and spices were used to cover up the bad taste.

In ancient times, salt was a very important economic product. In some places, salt was so scarce and costly, it was used as money. Caesar's troops received part of their pay in salt. This part of their pay was called their *salarium*. Our word *salary* comes from that Latin word.

You have heard the expression "not worth his salt." It dates back to the days when workers were paid partly in salt. It means that a person has not earned his wages.

Salt is an important part of your body. Your blood and your cells contain salt. You must have salt—but only a small amount. Too much salt in your diet can be very harmful to your body.

It is really the *sodium* in salt that is the trouble maker. Many foods contain sodium. But salt supplies the most.

Too much salt (sodium) in the diet increases the risk of brain stroke, kidney failure, and hypertension (high blood pressure). Hypertension is the nation's most common long lasting disease. It can lead to heart failure and death.

As a people, we consume too much salt. We have developed a "taste" for salt. Most foods we eat contain added salt—even dry cereals and baby food. To make matters worse, many of us overuse the salt shaker. We sprinkle salt onto food—even before we taste the food. It's a "sickening" habit.

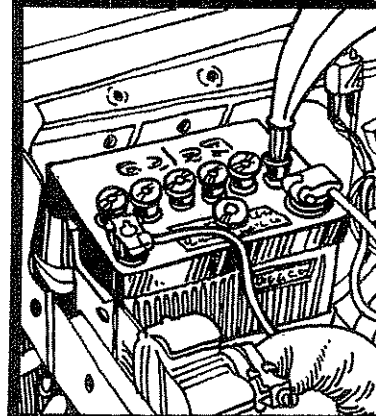
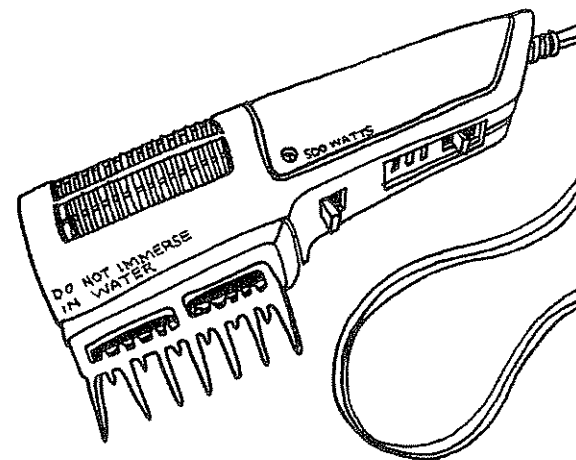
The path leading to high blood pressure starts early in life. Avoid that path. What can you do about it? As a starter, throw away your salt shaker. Then you should avoid salt-rich foods. Start with salty snacks like pretzels, salted peanuts, and pickles. Cut down on pizzas, too.

Make an effort to develop a taste for less salty food. You will taste a lot more than just salt. You will taste the *food* itself. And if you live in a place where it snows, pressure your community to cut back on the use of road salt to melt the snow. This salt can get into your drinking water.

Take charge of your health. NOW! It's later than you think!

WHAT KINDS OF LIQUIDS CONDUCT ELECTRICITY?

22



conductor: something that carries electricity

electrolyte: a solution that conducts electricity

nonelectrolyte: solution that does not conduct electricity

AIM | What kinds of liquids 22 | conduct electricity?

WARNING! Never touch anything electrical when you are in a bath. It can be very "shocking." It can even kill you. Bath water is a good conductor [kon DUCK ter] of electricity. And you know how dangerous electricity can be.

Now get ready for a surprise! Water by itself is a poor electrical conductor.

If this is true, then why does bath water conduct electricity?

The answer is simple. Bath water is not just "plain" water. It has soap dissolved in it. And you have learned that soap is made with a base. Bath water also has dissolved acids and salts from your body.

These dissolved solutes make water a good conductor of electricity. Water almost always has something dissolved in it. So, to be safe, you should always think of it as a conductor.

Solutions of acids, bases, and salts conduct electricity. Other liquids do not.

Solutions that conduct electricity are called *electrolytes* [ee LECK truh lites]. Solutions that do not conduct electricity are called *nonelectrolytes*.

Some acids, bases, and salts are better electrolytes than others.

Now here's another surprise! *Dilute* electrolytes conduct electricity *better* than concentrated electrolytes.

WHO NAMED ELECTROLYTES?

Michael Faraday was a famous English scientist in the 19th century. He made many important discoveries about electricity.

He tested many things to see if they would conduct electricity. He found that some solutions did. He named them *electrolytes*.



Figure A

TESTING ELECTROLYTES

We can test solutions like Faraday did by using a battery and a light bulb.

The bulb lights up if the liquid is an electrolyte.

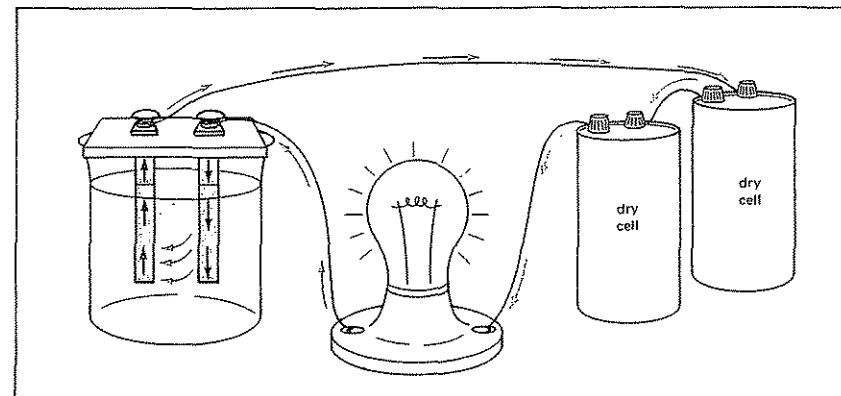


Figure B

The brightness of the light tells if the electrolyte is strong or weak.

- A bright light means a strong electrolyte (good conductor).
- A dim light means a weak electrolyte (poor conductor).
- No light means a nonelectrolyte (nonconductor).

WORKING WITH CHARTS

The chart below lists 15 liquids. They have been tested as in Figure B. The checks show how brightly the bulb lit up. (Your teacher may show you some of these tests.)

	Liquid	Light Brightness		
		Bright	Dim	No Light
1.	Concentrated sulfuric acid		✓	
2.	Dilute sulfuric acid	✓		
3.	Sodium chloride (salt)	✓		
4.	Sugar			✓
5.	Copper sulfate (salt)	✓		
6.	Boric acid		✓	
7.	Sodium hydroxide (base)	✓		
8.	Distilled water			✓
9.	Acetic acid		✓	
10.	Alcohol			✓
11.	Nitric acid	✓		
12.	Magnesium sulfate (salt)	✓		
13.	Glycerine			✓
14.	Carbonic acid		✓	
15.	Potassium hydroxide (base)	✓		

Answer these questions about the information on the chart.

- List the electrolytes: _____

- Which are strong electrolytes? _____

 - How do you know? _____
- Which are weak electrolytes? _____

 - How do you know? _____
- Which are nonelectrolytes? _____

 - How do you know? _____
- Which groups of liquids let the bulb light up? _____
- Which groups of liquids are electrolytes? _____

Do dry acids, bases and salts conduct electricity?

If the liquid in an electrolyte solution is evaporated, we have a dry powder left. We can get powder from acids, bases, and salts. Figure C shows how a powder is tested.

A dry acid, base, and salt were tested.

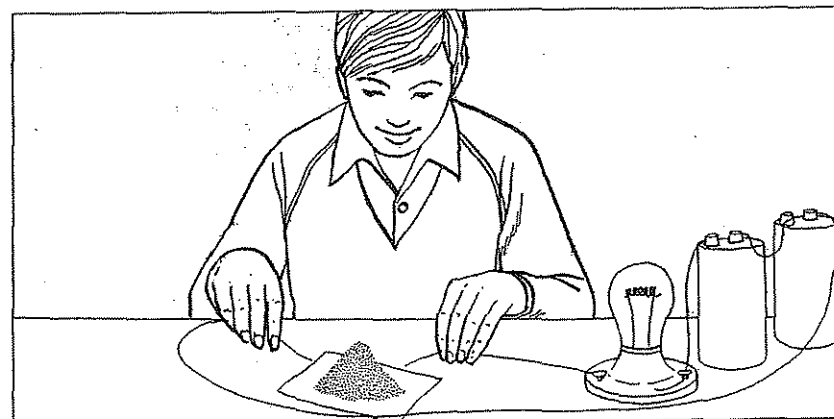


Figure C

The results are in the first column below.
Use the results from the first column to complete the chart.

Fill in this
column.

	Bulb Lights Up? Yes or No.	Electrolyte? Yes or No.
dry acid	No	
dry salt	No	
dry base	No	

7. Dry acids, bases, and salts _____ conduct electricity.
do, do not

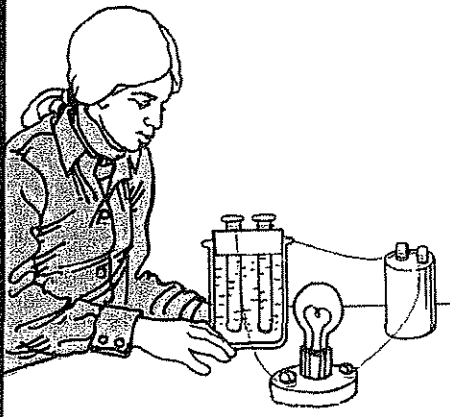
8. Dry acids, bases, and salts _____ electrolytes.
are, are not

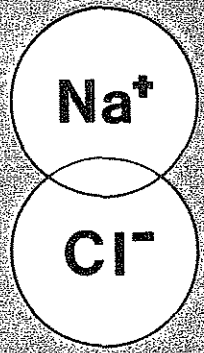
TRUE OR FALSE Write T on the line next to the number if the sentence is true.
FALSE Write F if the sentence is false.

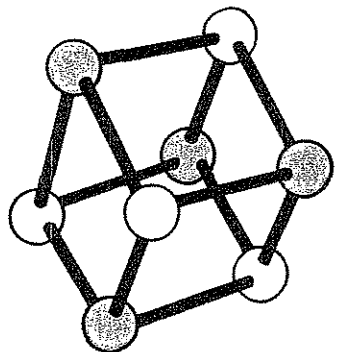
- _____ All solutions conduct electricity.
- _____ Salt solutions conduct electricity.
- _____ Acid solutions conduct electricity.
- _____ Solutions of bases conduct electricity.
- _____ Solutions that conduct electricity are called suspensions.
- _____ All electrolytes conduct electricity.
- _____ All electrolytes are good conductors of electricity.
- _____ Weak acids and bases are better electrolytes than strong ones.
- _____ Tap water is a good electrolyte.
- _____ Dry acids, bases, and salts are electrolytes.

WHY DO SOME SOLUTIONS CONDUCT ELECTRICITY?

23







ion: an atom that has a positive or negative charge

AIM 23 Why do some solutions conduct electricity?

Solutions of acids, bases, and salts conduct electricity. Solid acids, bases, and salts do not. Neither do liquids like alcohol, sugar water, distilled water, and glycerine.

Why do liquid acids, bases, and salts conduct electricity? Scientists explain it this way.

Matter is made up of atoms and groups of atoms called molecules. Most atoms and molecules have no electrical charge. They are *neutral*. The atoms of substances that are not acids, bases, or salts stay neutral. They stay neutral even when they dissolve. Solutions of acids, bases, and salts do not stay neutral.

What happens to an acid, base, or salt when it dissolves?

When an acid, base, or salt dissolves, its atoms do not stay together. The atoms unlock. When they unlock, they do not stay neutral. They take on electrical charges. Some atoms have a positive (+) charge. Some have a negative (-) charge. Charged atoms are called *ions*.

Ions let electricity pass through a solution.

Solutions that have ions are called *electrolytes*.

Liquid acids, bases, and salts form ions. That is why they conduct electricity.

Liquids like alcohol, sugar water, distilled water, and glycerine do not form ions. That is why they do not conduct electricity. They are *nonelectrolytes*.

EXPLAINING IONIZATION

Let us see what happens in a salt solution.

1. Table salt has atoms of sodium (Na) and chlorine (Cl).
2. One molecule of salt has one atom of sodium linked to one atom of chlorine.
3. Atoms of sodium and chlorine have no charge. Molecules of the solid salt NaCl have no charge.
4. NaCl in the solid state does not conduct electricity.
5. When NaCl dissolves, the sodium and chlorine atoms break away from each other.

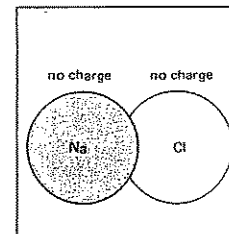


Figure A

One molecule of salt in the solid state

They take on electrical charges.

- The sodium takes on a positive charge.
- The chlorine takes on a negative charge.

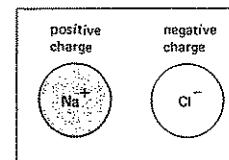


Figure B

One molecule of salt in the ionized state

The charged atoms are now called *ions*.

IONS CONDUCT ELECTRICITY.

Liquids that form ions are called *electrolytes*.

- Liquid acids, bases, and salts form ions.
- Liquid acids, bases, and salts are electrolytes.
- Liquid acids, bases, and salts conduct electricity.

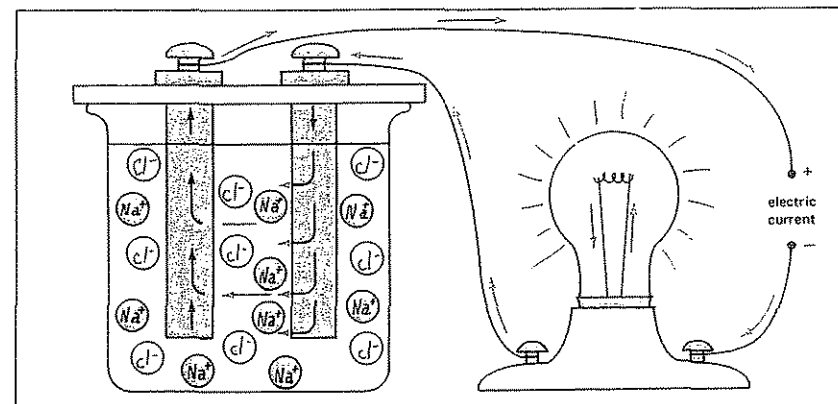


Figure C

WHO DISCOVERED IONS?

Svante Arrhenius [uh RAY nee us] was a Swedish scientist.

In 1887, when he was only 28 years old, he explained that ions form in solutions. He said that there are positive and negative ions.



Figure D

IDENTIFYING ELECTROLYTES

Look back at the chart on page 146.

1. Which liquids have the most or the strongest ions? _____
2. Which liquids have the fewest or weakest ions? _____
3. Which liquids have no ions? _____

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ A regular atom has a charge.
2. _____ An ion has a charge.
3. _____ Only positive ions have a charge.
4. _____ Liquids that conduct electricity are called electrolytes.
5. _____ Electrolytes contain ions.
6. _____ An electrolyte contains plus and minus ions.
7. _____ Sugar forms ions in water.
8. _____ Sugar water conducts electricity.
9. _____ Sugar water is an electrolyte.
10. _____ Salt water is an electrolyte.

COMPLETING SENTENCES

Complete the sentences with the choices below. Six of these terms may be used twice.

salts
positive
ions
acids

electrolytes
no
bases

negative
atoms
conduct

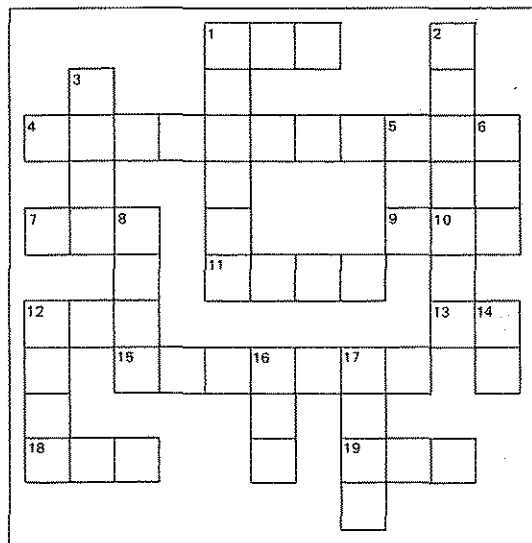
1. Matter that is electrically neutral has _____ charge.
2. Regular _____ are electrically neutral.
3. Regular atoms have _____ charge.
4. Atoms that have a charge are called _____.
5. Some ions have a _____ charge; some have a _____ charge.
6. Atoms of _____, _____, and _____ form ions.
7. Ions _____ electricity.
8. Solutions that conduct electricity are called _____.
9. Liquid _____, _____, and _____ are electrolytes.
10. Liquids like alcohol and distilled water do not form _____. They are not _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------------------|-------------------------------------|
| 1. _____ ion | a) kinds of charges |
| 2. _____ positive and negative | b) do not conduct electricity |
| 3. _____ electrolyte | c) liquid that conducts electricity |
| 4. _____ regular atom | d) charged atom |
| 5. _____ dry acids, bases, and salts | e) has no charge |

CROSSWORD Fill in the blank spaces by following the clues
PUZZLE across and down.



Across

1. Base used to make soap
4. Liquid that can conduct electricity
7. A litmus paper color
9. Abbreviation for the first day of the weekend
11. Made of sodium and chlorine
12. Bend forward at the waist
13. What a side-to-side head shake means
15. Neither acid nor base
18. Last part
19. Charged atom

Down

1. Indicator paper
2. Short for Matthew
3. A litmus paper color
5. What a head-nod means
6. Take in food
8. Where everything that is up must go
10. Girl's name
12. First, second, third, or home
14. Where to find the "Wizard"
16. A plaything
17. Lemon juice, for example

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